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ABSTRACT

This package of materials, developed for teachers in the elementary schools, is designed to help the teacher educate the future voter so that he will be knowledgeable and concerned about environmental problems. This package on Ecosystems has two goals. The first is to help the teacher understand some basic facts and concepts of ecology and the second is to help the teacher integrate environmental education activities into the existing curriculum. Behavioral objectives and major concepts are listed. Ten learning modules are included in this packet. The module titles include: The Web of Life; Interrelationships Among Living Things; Biotic and Abiotic Factors in the Environment; Adaptations in Living Things; Seed Dispersal and Succession; Food Chains and Energy Pyramids; Plants and Man; Man and Ecosystems; The Shape We're In; and The Only Earth We Have. Each module contains assignments, reading materials, teaching suggestions, learning activities, and student projects. "A Guide to Environmental Education Resources," prepared by the Science Division of the State Department of Public Instruction of North Carolina, and a posttest on ecosystems are included with this package. (BT)

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ECOSYSTEMS

A SELF-INSTRUCTIONAL MODULAR PACKAGE FOR ELEMENTARY SCHOOL TEACHERS

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PRELIMINARY VERSION

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PURPOSE OF THE ECOSYSTEMS PACKAGE

Pollution, depletion of natural resources, and overpopulation affect the quality of our lives. Our environment continues to deteriorate. Solving these problems is a complex task. As an elementary school teacher you are charged with educating our future voters so they will be knowledgeable and concerned about environmental problems. The material in this program is designed to help you do that.

This package on "Ecosystems" has two overall goals. The first is to help you understand some basic facts and concepts of ecology. The major concepts to be developed are:

1. All living things are interdependent.
2. Tampering with ecosystems may have unforeseen consequences.
3. Man is a part of nature.
4. We are dependent on green plants for food and oxygen.
5. Living things are adapted for their specific environments.
6. Abiotic factors such as light, heat, and moisture influence the living environment.
7. Change occurs constantly on our planet.
8. Matter cycles; energy is lost.
9. Man is dependent on nature for food, clothing, shelter, recreation, and medicine.

The second major goal is to help you to integrate

environmental education activities into the existing curriculum.

More specifically, after completing the ECOSYSTEMS package, you should have the following behavioral capabilities:

1. Given a description of biological interaction, be able to tell whether it is mutualism, commensalism, competition, predation or parasitism.

2. Given a diagram of the water cycle, the nitrogen cycle, or any other matter cycle, be able to tell when the molecule is part of the abiotic environment and when it is part of the biotic environment.

3. Be able to predict the eventual consequences if all decomposers were eliminated from our planet.

4. Given a diagram of a food chain, be able to identify the producer, first, second and third-order consumers.

5. Given several sequences of organisms, be able to pick out the correct food chain.

6. Given a particular food, be able to tell what order consumer man is when he eats it.

7. Given a food chain, be able to pick out the level with the least energy.

8. Be able to list three abiotic factors of the environment, and one way in which each affects living things.

9. Given a description or a picture of a room and its contents, be able to trace back the origin of each item to plants or non-plants.

10. From a list of possibilities, be able to pick out the items necessary for photosynthesis, and those which are the products of photosynthesis.

11. From a list of possibilities, be able to pick out the things necessary for respiration, and those which are the products of respiration.

12. Given a picture or a description of an organism, be able to tell how it is adapted for survival in its environment.

13. Given an unordered list of five plant communities in succession, be able to correctly order them from pioneer to climax community.

14. Be able to list two causes of air pollution.

15. Be able to list two causes of water pollution.

16. Be able to list five things the consumer can do to help protect the environment.

17. Be able to compare the relative impact on the environment of the average American and the average world citizen.

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18. Be able to assess the affects of population on pollution.

19. Be able to demonstrate an understanding of the "Tragedy of the Commons" concept by giving an example of one such tragedy.

20. Be able to recognize the definitions of abiotic, biodegradeable, biotic, consumer, ecology, ecosystem, photosynthesis, predation, producer, recycling, respiration, and succession.

In addition, you should

21. Be able to write environment-related problems for some of the mathematics concepts you teach.

22. Be able to plan, carry out, and follow up a field trip in which students actively participate.

23. Be able to identify and obtain resources for teaching environmental topics. Such resources might include guest speakers, books, periodicals, pamphlets, or films.

DESCRIPTION OF THE ECOSYSTEMS PACKAGE

This is a self-instructional package designed to help you reach the objectives. There are ten modules, each covering a major topic of environmental education.

Each module contains a tape recording and a series of pictures that goes with the tape. In addition, each module has a workbook which is yours to keep. The workbooks contain your assignments, and some suggestions for teaching environmental concepts. The last part of the package identifies some environmental education resources including books, games, and films.

Begin the program with module #1: The Web of Life. As you work through the modules you will come across fifteen assignments. One assignment will involve reading a book about man and his environment. All of the other assignments are quite brief. All assignments should be completed in duplicate. You will keep one copy for your own use, and hand in one copy when you complete the package. Be sure to complete all of the assigned work before our meeting on . Bring the tape recordings, the pictures, and a copy of all the completed assignments to that meeting.

Please turn to module #1.

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MODULE #1: THE WEB OF LIFE

Like the Beatles, hot pants, and Watergate, ecology is one of those terms that suddenly becomes popular. Most everyone sees it, hears it, and probably talks about it. In the case of "ecology", not everyone who uses the word really knows what it means. Here is a simple definition:

> Ecology is the study of the interrelationships of living things with each other and with their environments.

Nothing lives in isolation. Every living thing is related to other living things, and to the non-living parts of the environment. The interrelatedness of living things is one of the most important biological concepts. John Muir, a famous conservationist, once said, "When we try to pick out anything by itself, we find it hitched to everything else in the universe." We can think of the earth as a giant spider web. If you destroy one strand you run the risk of the whole thing collapsing.

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ASSIGNMENT 1

Read one book about man and his environment. You may choose any one of the books listed on page one of "A Guide to Environmental Resources" or on page "Additional Recommendations for Teachers." Both of these lists are in the last section of the package, "Environmental Education

Resources."

Pick out one or two main points of the book and write your reaction to them. This reaction paper should be about two typewritten pages in length.

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Listen to tape #1 "The Web of Life." There is a series of pictures that goes along with the tape.

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TAPE #1: THE WEB OF LIFE

When we talk about one kind of living thing in an area - one species - we call it a population. Thus we have a population of people, a population of dogs, and a population of sugar-maple trees. When we talk about groups of interrelated living things and their environment we are talking about an ecosystem.

A pond is an ecosystem. It has aquatic plants, fish, insects, frogs, and other interdependent organisms. These organisms interact with one another. All of these in turn interact with their environment - the water of a certain temperature and acidity, a certain amount of sunlight, etc.

A forest is an ecosystem - trees, shrubs, herbs, and a variety of animals all interacting with the air, water, and light. This complex network of interactions is sometimes referred to as the web of life. Each part of the web is tied to other parts.

Here is an example of what happens to the web of life when one strand is broken. The White River National Forest in Colorado was a beautiful, healthy pine forest. Bark beetles were permanent residents there, but the vigorous trees were able to withstand their attacks. The number of bark beetles was kept in check by woodpeckers who lived in the forest. There were numerous other plant and animal species, all contributing to the balance of nature in that forest.

One day there was a very heavy wind. Many trees were partially uprooted. They remained alive, but bent and weakened. The undersides of these trees were buried among

crushed branches. This was ideal for the bark beetles. They could attack the trees and stay out of the way of the woodpeckers.

The weakened trees could not withstand the onslaught of the bark beetles. In a few years the entire forest was dead or dying. Animals which had used the forest for food and shelter were no longer able to survive there. Many died. Others emigrated to other areas. A wind which damaged some trees also damaged many animal populations. The web of life is such that it is hard to disturb one part without affecting all of the others.

The idea of interconnectedness of the web of life can be conveyed to students with pick-up sticks. If you scatter pick-up sticks in a small space, the students will find it very hard to pick one up without disturbing the others.

It is important that students learn about the web of life. The aim is that they will want to preserve the environment. The first step is to help them become aware of nature.

The workbook for module #1 contains some ideas for bringing about this awareness. The workbook also contains directions for creating small ecosystems in the classroom. Please turn to the workbook.

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TEACHING SUGGESTIONS: THE WEB OF LIFE

Nature is all around us for us to enjoy, but many people are not aware of it. These exercises are designed to help students appreciate their environment by awakening them to what is out there.

1. Establish Rules for Field Trips

Develop whatever set of rules you feel comfortable with. Some possibilities are: no wandering off, buddy system, no loud talking. The first two are concerned with safety. The third is necessary if you are going out to see nature as it really is. Loud voices would scare away many of the animals you have come out to see.

Arrange a signal which will begin absolute silence. This will be useful when you are having the students listen to bird calls, crickets, wind whistling or other natural sounds. It will also come in handy if you need to get their attention quickly.

2. Beware of potential dangers.

Before going into the woods have an in-class lesson about poisonous organisms. Fortunately the very dangerous organisms are unlikely to be encountered. Do not dwell on these. Calmly point them out so the students will be able to avoid problems. Draw pictures on the blackboard of:

a. Poison Ivy

b. Poison Sumac

c. Poisonous Snakes

d. Black-widow Spiders

(Space for pictures)

3. Treasure Hunt.

Divide the class into small groups (approximately five students in each group.) Each group is to locate as many of the following as possible. Have them draw maps or otherwise describe how to find the various objects. They should be careful not to disturb anything.

1. something yellow
2. something red
3. something blue
4. pine cone
5. an acorn
6. a bird's nest
7. a mushroom
8. a heart-shaped leaf
9. woodpecker holes in a tree
10. a rotting log

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Let the first group that finishes take the rest of the class on a guided tour. Or, if no group finds all of the items by the end of the allotted time let the group which located the most objects conduct the tour.

4. Have a "touching" treasure hunt.

The treasure hunt described in (3) makes extensive use of our eyes. Vision is an important sense, but we should not rely on it alone. Students need practice in using their other senses.

For the "touching" treasure hunt, have the students locate some of the following.

1. something rough
2. something smooth
3. something velvety
4. something spongy
5. something prickly
6. something moist
7. something crumbly
8. something sharp
9. something fuzzy
10. something furry
11. something soft
12. something hard
13. something hairy
14. something scaly
15. something slippery

16. something rubbery

17. something slimy

18. something silky

19. something warm

20. something cold

5. Concentrate on listening

a. Take the students out to a grassy area and have them spread out. Each student should close his eyes and listen for a minute. Then he should write down what he heard. Repeat the listening period and have the students write down anything else they heard.

b. Declare a silent time when the class is out in the woods. Have the students stand still, close their eyes, and listen.

c. Call "listening times" in the classroom, and on the school playground.

d. Have the students do "listening times" at home, on the way to school, in the lunchroom, etc.

6. Sense of Smell

a. Give each student a paper or plastic bag to use for collecting. Have the students bring back samples of things they could smell while out in the woods.

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b. Demcnstrate the ccnnection bwtween tasting and smelling. Bring in a few diced foods such as apple, onion, and potato. Have a student hold his nose and close his eyes. Put a sample of one of the foods on his tongue. He may then open his eyes, but must continue to hold his nose. Ask him to try and identify the food substance on his tongue.

7. The All-senses Treasure Hunt

Divide the class into groups of approximately five. Have some of the groups find the best sight, sound, smell, and touch in a given area. Have the other groups locate the worst sight, sound, smell, and touch in that area. Be sure to mention that we have a fifth sense - taste - but it is not a good idea to gc around tasting unknown things.

As a follow-up to this activity, have each student look for the best and worst sights, sounds, smells and touches at home and on the way to school.

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ASSIGNMENT 2

Write a plan for a field trip which will actively involve your students. Include the purpose of the field trip and the procedures to be followed.

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8. Poetry and the Senses

a. Write the following on the blackboard:

"I think that I shall never see
a poem lovely as a tree."

Lead a discussion about the meaning of this verse by Joyce Kilmer.

b. Then write Ogden Nash's poem on the blackboard:

"I think that I shall never see
a billboard lovely as a tree.
Perhaps, unless the billboards fall
I'll never see a tree at all."

Ask the students to comment.

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ASSIGNMENT 3

There are many other poems you could use to awaken your students to the beauty of nature. Locate three such poems and list the name and author of each.

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SETTING UP AN AQUARIUM

Materials needed:
- a 5 or 6 gallon rectangular tank
- aquarium gravel
- aquatic plants
- aquatic snails
- small fish

1. Clean the tank.
   Make sure the tank is thoroughly clean. If you use detergent, be sure to rinse the tank well to remove all residues.

2. Add gravel.
   Spread the gravel on the bottom of the tank to a depth of about two inches. If you wish, use a few small colored rocks to enhance the appearance.

3. Position the aquarium.
   Choose a good location for the aquarium. A northeast corner should provide good indirect sunlight. Once filled, the aquarium should not be moved or leaks may occur.

4. Fill the tank with water.
   Place a large piece of paper over the gravel. Pour pond water or tap water into the tank until the water level is one inch from the top. If you use tap water it will need to stand for at least 48 hours, or the chlorine will kill the inhabitants of the aquarium. Remove the paper after filling.

5. Add plants.
   Add some rooted and some floating aquatic plants. Sagittaria and Valisneria are suitable rooted plants. Elodea and Cabomba are suitable floating plants. Arrange the plants toward the back of the aquarium so they will not block the view of the fish. Let the aquarium stand for several days to allow the plants to start growing.

6. Add the fish. Add a few small fish. The rule of thumb is about one inch of fish per gallon of water. Guppies are well suited for use in an aquarium because they are small, active, and can withstand a wide variety of temperatures.

7. Add the snails.
   Add about six snails. They will help keep the aquarium free of algae. If available, add a clam or oyster shell. The shell will slowly dissolve, providing the calcium for the snail's shells.

8. Cover the tank.

Cover the tank with a piece of glass or plastic wrap to help keep the water clean, and to reduce water loss due to evaporation.

9. Feed the fish sparingly.

Feed the fish with a little fish food every couple of days. Be careful not to overfeed. Once in a while put in tiny amounts of chopped earthworms or beef.

Once you achieve a balanced aquarium all you need to do is sit back and enjoy it. However, you may have to do a little troubleshooting at first until you achieve this balance. The following list of potential problems and solutions may help you to achieve a balanced aquarium.

1. You may get a green slimy growth on the sides of the tanks. This is excessive algae growth, and it will cut down on the visibility. It is caused by too much light or too few algae consumers. To solve the problem, try adding a few more snails. If this does not work, try wrapping black paper around the tank to cut down on the light. You may have to clean the tank with an aquarium scraper.

2. You may notice that all of the fish stay pretty close to the surface of the water. This is an indication of insufficient oxygen, caused by overcrowding of fish or snails. To solve the problem, try planting more rooted plants. This will result in greater oxygen production.

3. The water may have a dirty appearance due to excessive waste material. To solve that problem, increase the number of snails, and cut down on the amount of food given to the fish.

It might be a good idea to purchase an automatic filter. This will help to keep the aquarium clean, and it will also aerate.

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SETTING UP A TERRARIUM

Materials:

a. A wide-mouthed glass container such as a fish bowl
b. Charcoal, gravel, and potting soil
c. Plants, each with a small ball of soil around its roots.

1. The Soil

Put a thin layer of charcoal in the bottom of the container. Then add a layer of gravel, about twice as thick as the charcoal layer. Pour in potting soil until the jar is between one-fourth and one-third full.

2. The plants.

Arrange several small plants attractively in the container. Make sure the roots are covered with soil.

3. Finishing Touches

Add some pretty stones or shells as desired. Lightly water the terrarium. Cover the container with glass, or with wax paper or plastic and a rubber band.

4. Maintenance

Put the terrarium on a window sill or under a lamp. Water when needed, probably about once a week.

You may wish to add some small animals such as earthworms, toads, and lizards to the terrarium. Earthworms will eat decaying material in the soil. Add some flies or other insects for food for the toad and lizard.

Both the aquarium and the terrarium would make excellent additions to an elementary school classroom. Students will enjoy looking at them, and at the same time they will be learning science. As microcosms of nature, aquaria and terraria can be used to demonstrate some of the major concepts of ecology.

This completes module #1. Please turn to module #2.

MODULE #2: INTERRELATIONSHIPS AMONG LIVING THINGS

As you have seen, the idea that all living things are interdependent is a central concept in ecology.

Module #2 examines the concept of interdependence in more detail. There are many different types of relationships among living things. Please listen to tape #2 for a discussion of some of these interrelationships.

IDEAS FOR TEACHING ABOUT INTERRELATIONSHIPS

1. Pick-up Sticks

Toss some pick-up sticks on the table. Ask for a volunteer who is a good player. Let this student try to pick one out without moving any others. After a few students try this, blindfold one of them and let him try it again. Establish the parallel between this and the natural world. Everything is connected to everything else. Sometimes man is blind to the specifics of the web.

2. Study an ecosystem

Divide the class into groups. Some groups should look for examples of organisms helping each other; other groups should look for evidence of organisms harming each other. After a while you might have the groups switch tasks. Depending on the sophistication of the class, you might have

them look for the more subtle relationship of commensalism. You might even wish to teach them some of the terms such as mutualism, predation, etc.

This can be repeated for different kinds of ecosystems. A forested area, a grassy area, a pond and a a creek are all possibilities.

3. Interrelationships in Human Society

Study the classroom ecosystem. For example, have the students pick out examples of parasitism in the classroom. Another possibility would be to have students look for examples of mutualism in government. Examples of competition among people are also numerous.

4. The Old Lady and the Army

Tell the students about the time when a war was lost because an old lady moved out of her house. The story goes like this:

Once upon a time, a long time ago, there was an old lady who lived in the country. She was a kindly old lady who took care of a lot of cats. One day she decided to move to the city with her cats. In a short time the army was losing most of its battles.

Why? Challenge the students to think of possible

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explanations. Encourage them to use their imaginations. Praise all those who come up with creative explanations. When you are ready, tell them what actually happened in this case:

The little old lady lived in a house near some fields of clover. Her cats roamed the area and ate a lot of field mice. These field mice ordinarily eat a lot of bumblebees. Without the cats, there was an increase in the number of mice. All of these mice ate every bumblebee in sight. There were not enough bumblebees to pollinate the clover. Thus there was a poor clover crop. With inadequate clover there was not enough hay to feed the cattle. The cattle became scrawny and sickly. So there was not enough beef to feed the army. And everyone knows a hungry army cannot fight very well.

Write the various steps on the blackboard:

army

beef

hay

clover

bumblebees

mice

cats

old lady

Among the relationships present in this series are the following: The old lady and the cats is an example of commensalism if you think the old lady was not benefitted, and

mutualism if you think she was benefitted by having cats. The cats and mice are an example of predation, as is the mice-bumblebees relationship. The bumblebees and clover are mutually benefitting.

5. Creative Writing

To integrate ecology and language arts, you may wish to assign the students to write stories like "The Old Lady and the Army." Volunteers could read their stories to the class. After each story has been read you could help the class pick out the examples of various kinds of interrelationships.

6. Predator-prey Relationships

Have the students look for predator-prey relationships in the area surrounding the school. Examples might include a bird eating a worm, a spider eating a fly, and a toad eating an insect.

Please complete this summary sheet for interrelationships.

The answers appear at the end of the workbook.

Part I

Briefly define:
Commensalism

Competition

Mutualism

Parasitism

Predation

Part II
Fill in the name of the relationship.

EXAMPLE	NAME OF RELATIONSHIP
1. A butterfly feeds on the nectar of a flower. At the same time it pollinates the plant.	----------
2. Grass and dandelions are in the same lawn.	----------
3. Moss sometimes grows on tree trunks. This helps the moss without harming the tree.	----------
4. A fox pounces on a rabbit and eats it.	----------

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5. Some leaves on a maple tree have yellow spots where a fungus is growing. ----------

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ASSIGNMENT 4

On a separate sheet of paper, give examples of other relationships you might point out to your students. Concentrate on examples in the area surrounding your school, and in the terrarium and aquarium you will be setting up.

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ANSWERS TO THE SUMMARY SHEET FOR INTERRELATIONSHIPS

Part I.

In commensalism, one partner is helped and the other is neither helped nor harmed.

In competition both organisms are harmed.

Mutualism benefits both partners.

A parasite benefits by harming its host.

The predator benefits by destroying its prey.

Part II.

Grass and dandelions are in competition for water and minerals.

The moss and the tree are commensals. One benefits, the other is unharmed.

A fox eating a rabbit is a classic example of predation.

The fungus-maple tree relationship is an example of parasitism. The fungus is taking food away from its host.

If you had trouble filling out the summary sheet you may wish to listen to the tape on interrelationships again. If you feel you understand the concept that all living things are interdependent. Go on to module #3.

TAPE #2: INTERRELATIONSHIPS

There is a variety of possible relationships among living things. Sometimes two organisms depend on one another and both benefit from their association. For example, termites live in a mutualistic relationship with minute organisms called flagellates in their stomachs. The termite can chew wood, but cannot digest the cellulose in it. The digestion is done by the tiny organisms. The flagellates benefit because they get food brought to them. They could not possibly get wood by themselves. The termite benefits by having the cellulose changed into a form that they can use for energy.

Another example of mutual benefit or mutualism sometimes occurs between algae and fungi. If you look at the bark of a tree you will often see a flaky gray-green growth. This is an example of a type of plant called lichen. Actually lichen is made of two plants living in mutual benefit. The algae has chlorophyll and is able to use sunlight energy to produce food for its own use and that of the fungus. The fungus has a system of root-like threads which anchors the plant to the tree and obtains water.

Sometimes two organisms live in close association where only one benefits. If the second organism is unharmed, we call the relationship commensalism. One type of algae lives on the shells of certain turtles. The algae are getting a place to live. The turtle is neither helped nor harmed.

Remora fish often attach themselves to sharks, without harming the sharks. This is another example of commensalism. The fish get food when bits of the shark's kill float by them.

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The remora also gets free transportation.

In mutualism, both organisms benefit. In commensalism, one benefits and the other is unharmed. In a third kind of relationship, parasitism, the parasite benefits and the host is harmed.

You have undoubtedly heard of many parasites of man. As an example, Athlete's Foot is caused by a parasitic fungus. Streptococcus bacteria get food from us and at the same time cause the discomfort of strep throat.

Almost all living things have parasites. There are parasites of plants, such as the fungus which causes corn smut. Parasites harm, but usually do not kill their hosts. If the host were to die, the parasite depending on it would have to find another host or it too would die.

There is another type of relationship which is not helpful to either of the organisms involved. This is called competition. Sometimes two animal populations compete for food. For example, snakes and hawks both feed on rodents. If there were no hawks there would be more snakes.

As another example, man is in competition for food with insects.

Cactus and yucca both grow in the desert. They are competing for space and, most importantly, for water. The numbers of each kind of plant are held down by the presence of the other.

There are many other examples of predation, mutualism, commensalism, parasitism and competition in nature. Elementary school students are capable of understanding the concept of interdependence. It is probably unnecessary for

them to learn the names of these relationships. The aquarium and terrarium can be used to study interrelationships. In addition, as you take the students outside, be alert for examples of these relationships.

The workbook contains some ideas for teaching about interrelationships and a sheet for you to summarize what you have learned. Please turn to the workbook.

MODULE #3: BIOTIC AND ABIOTIC FACTORS IN THE ENVIRONMENT

Thus far we have been concentrating on the relationships between living things. You have seen that two different organisms may help each other or harm each other. In some cases only one organism is helped. The general point is that no organism is an independent entity. Each living thing is dependent upon other living things.

But living things are only part of an ecosystem. Now we will add in the other essential part of any ecosystem - the non-living environment. Listen to tape #3 to hear about the living and non-living parts of our environment and how they interact.

TAPE #3: ABIOTIC FACTORS IN THE ENVIRONMENT

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Living things are made up of atoms of carbon, hydrogen, oxygen, nitrogen, and many other elements. There is a very large supply of these atoms in our environment but it is by no means an infinite supply. The matter in living things must eventually be returned to the non-living environment or we would run out.

The movement of matter from the non-living environment to living things and back to the non-living environment is called a matter cycle. There are many different matter cycles - the water cycle, the carbon cycle, the nitrogen cycle, the calcium cycle, and many others. A few examples will be presented to give you a general idea of how matter cycles.

First, consider the water cycle. Scientists study pictures of Mars to see if there is any life on that planet. One of the first things the scientists look for is evidence of the presence of water. There is a very good reason for this: Life as we know it could not exist without water.

There is always water in the atmosphere. Periodically some of the water vapor condenses and falls to earth in the form of rain or snow. This water may evaporate from a lake and in that way return to the atmosphere. If that happens, the cycle has been completed without involving a single living thing.

But the water from rain or snow may become part of a living thing. Plants absorb water through their roots. Animals drink water. All living things need water in order to live.

This water would not remain in the plant or animal indefinitely. Water is constantly being given off as a result of a variety of life processes. Also, when living things die, decomposers break them down to water and other simple chemicals. This water reenters the atmosphere by evaporation where it will later condense and become precipitation.

Before considering other matter cycles it would be helpful to talk about some of the life processes involved in these cycles.

Respiration is carried on by all living things. It is the process by which food is oxidized to provide energy for life. In most organisms the process of respiration requires food and oxygen, and it results in the production of carbon dioxide and water as well as energy. In terms of matter cycles, respiration removes oxygen from the non-living environment and adds carbon dioxide and water to the non-living environment.

Another important life process is photosynthesis. Only green plants can carry on photosynthesis. "Photo" means light. Energy from sunlight is captured by the chlorophyll in green plants. This provides the energy for combining water and carbon dioxide to make food and oxygen. Notice that photosynthesis can be considered the reverse of respiration. Ent.

Now we are ready to consider the carbon cycle. Our air is made up of .03 per cent carbon dioxide gas. Life as we know it is dependent upon keeping approximately that amount of carbon dioxide in the air. Without living things there would be no carbon cycle. Carbon dioxide would remain in the

atmosphere.

Plants remove carbon dioxide from the atmosphere and use it in photosynthesis. Plants and animals add carbon dioxide to the atmosphere as a result of respiration.

When living things die, bacteria of decay decompose them into simple compounds such as carbon dioxide and water.

The whole cycle is shown in the diagram

(Long pause)

You have now seen in some detail how matter cycles between the living and the non-living environment. The idea of cycles is central in a study of ecology. A similar idea occurs frequently in human affairs. Think about cycles as you listen to this beautiful American folk song.

Where have all the flowers gone, long time passing,
Where have all the flowers gone long time ago?

Where have all the flowers gone?
Girls have picked them everyone.

Where have all the young girls gone?
They've taken husbands everyone.

Where have all the young men gone?
They are all in uniform.

Where have all the soldiers gone?
Gone to the grave everyone.

Where have all the graveyards gone?

Gone to flowers one by one...

Please turn to the workbook for teaching suggestions.

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PART II: ABIOTIC FACTORS

Living things depend on their environment in many ways. The environment can be thought of as a two part entity: the living environment and the non-living environment.

Your pet dog, the plants and animal foods you eat, and the bacteria in your intestine are all part of your living or biotic environment. The "bio" in biotic means life.

The sunlight shining on you, the air you breathe, and the water you drink are all part of your abiotic or non-living environment. The prefix "a" means without. Therefore abiotic means without life.

Some major abiotic factors of the environment are temperature, light, and moisture. Water is essential for life on earth. The amount of water determines the kind of life in a given area. As you might suspect, maple trees cannot survive for long in the desert.

Temperature is another important abiotic factor of our environment. The rate of growth of many organisms is affected by the surrounding temperature. In general, bacteria will double their metabolic rate for every ten degree rise in temperature. That's the reason why refrigerated foods keep longer, and why frozen foods keep best of all.

Only warm-blooded organisms - birds and mammals, including man - keep their body temperatures constant regardless of the external temperature fluctuations. Therefore the rate of growth is not determined by climate. Nevertheless, we, as all living things, can only survive in a certain temperature range. If it ever gets too hot or too cold on earth, life as we know it would cease to exist.

Light is a vital abiotic factor. Without sunlight, plants could not carry on photosynthesis and we would soon run out of oxygen, food, and energy.

Please turn to the workbook for teaching suggestions.

REPEAT OF SONG

Where have all the flowers gone, long time passing,
Where have all the flowers gone long time ago?

Where have all the flowers gone?
Girls have picked them everyone.

Where have all the young girls gone?
They've taken husbands everyone.

Where have all the young men gone?
They are all in uniform.

Where have all the soldiers gone?
Gone tc the grave everyone.

Where have all the graveyards gone?
Gone tc flowers one by one...

TEACHING SUGGESTIONS: MATTER CYCLES

The important points for you to develop with your students are:

1. Matter cycles between the living and the non-living parts of our environment.

2. Bacteria of decay and other decomposers are essential parts of matter cycles.

The following activities are designed to help you teach those concepts.

1. Use the aquarium to help develop the concept of matter cycles. Ask what happens to a fish that dies. Establish the idea that bacteria decompose it. As a result simple materials are returned to the fish's environment where they can be used by plants to make food and oxygen.

2. Visit a rotting log. Have the students pick it apart to see how it is being decomposed. Observe the various organisms - sow bugs, termites, mushrooms, and bracket fungi. Point out that there are bacteria there, too, but these are too small to see without a microscope. The log will eventually be completely broken down. This returns the matter to the air and the soil.

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3. Challenge the students to be creative in imagining how matter cycles. Have them write a paragraph or so in response to statements like:

> "You are a drop of water in the sweat on a horse's brow in North Carolina. Tell us about a voyage you might take to get you onto a leaf of a Redwood tree in California."

This may bring in some geography learning as well as ecology.

As another example:

> "Assume you are a carbon atom in a cell of a cow. Trace a trip that would take you into the non-living world and back into that same cow."

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ASSIGNMENT 5

Write a similar statement which will bring in history learning in addition to ecology.

****

4. Show that we give off water vapor when we breathe. Have students breathe onto a mirror or window pane. Notice the steamy appearance. Ask what other ways we get rid of excess water.

5. Talk about our planet "Water." (Some people say that "Earth" is a misnomer since more than seventy per cent of our

planet's surface is covered with water.) Living things are more than 90 per cent water. Human beings can survive without food for weeks, without water for only a couple of days.

6. Show the rain cycle in miniature. Fill a pyrex pot with water and heat the pot on a hot plate. When the water is boiling vigorously, fill a frying pan with ice cubes and hold it about six inches above the pot. This will initiate a complete water cycle. Water vapor from the boiling water is cooled by the cold bottom of the frying pan. This causes water droplets to condense on the bottom of the frying pan and then drop back into the pot of water.

7. Use plants to demonstrate some aspects of the water cycle. You might take the students outside first thing in the morning to show them dew. Plants also need water. In the terrarium the water cycles back and forth. Plants give water off and then they take it in. If the terrarium were left uncovered you would have to add a lot more water to compensate for loss due to evaporation.

8. Where Have All The Flowers Gone?

Goal: To help the students understand that ecology is related to many aspects of life - including the cycle described in this popular folk song.

Specific Objectives:

1. The students will be able to sing "Where have all the flowers gone?".
2. Each student will be able to write a paragraph about what the song means to him.

Activities:

1. Teach the song to the students.

WHERE HAVE ALL THE FLOWERS GONE

Where have all the flowers gone, long time passing,
Where have all the flowers gone long time ago?

Where have all the flowers gone?
Girls have picked them everyone.

Where have all the young girls gone?
They've taken husbands everyone.

Where have all the young men gone?
They are all in uniform.

Where have all the soldiers gone?
Gone to the grave everyone.

Where have all the graveyards gone?
Gone to flowers one by one...

2. Discuss the meaning of the song. There are no right answers. Encourage each child to find his own meanings. In order to reach the goal stated above you will need to develop the following ecological concepts:

a. All living things are interrelated.

b. Life is dynamic. Living things are born. They change, age, and die.

c. In nature, matter recycles. Plants provide beauty, food, and oxygen for other living things. When these in turn die and decay, they provide nutrients for the growth of more plants.

This song is packed with ideas that would be worthwhile topics for discussion. This activity concentrates on an ecology-related goal. You may have additional goals in mind. In that case you will want to expand some additional concepts. Some possible topics for discussion are: "Dying for one's country", "The draft", "Should women serve in the armed forces?", and "The inevitability of war". Or you might expand on "They've taken husbands everyone." Does every young girl see marriage as part of her future? What are some alternatives?

Please turn the tape back on. The song will be repeated to help you learn the tune.

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TEACHING SUGGESTIONS: ABIOTIC FACTORS

1. The dependence of living things on abiotic factors is evident in a poem called "April Rain" by Robert Loveman. It appeared in Harper's magazine in 1901.

Read this excerpt to the class.

It is not raining rain to me,
    It's raining daffodils;
In every dimpled drop I see
    Wild flowers on the hill.

Ask how they feel about rain. Many of us think of rain as an annoyance. This might be a good place to consider some of the positive aspects of rain. Rain may ruin picnics, but it also enables crops to grow.

2. Rain Walk

Have the students put on rain wear and take a walk in the rain. Choose a time when the weather is mild and the rain gentle. It would be especially appropriate if done in April. At some point in the walk have the students stand still and silent for a minute and listen.

3. The initial stages of setting up an aquarium are ideal for demonstrating the effect of the abiotic environment on living things. Recall that the green slime on the sides of

the tank are a result of excess light. Too little oxygen can cause fish to stay near the surface, or even break the surface while gasping for air.

4. Demonstrate the effect of water on plants. Put two of the same kind of potted plant in a sunny location. Water only one, but do it when the students are not around. After a week or so the leaves of the unwatered plant will begin to wilt. Some of the students will probably notice the wilting or you can point it out. Challenge the students to explain what happened. After they have run out of guesses, tell them that you have watered only one plant. The plant will most likely revive when watered for a few days.

5. Demonstrate that green plants need light. Put one potted plant in a sunny location and a similar plant in a cabinet. Water them equally. After several days the difference will become obvious.

6. Discuss the effects of temperature on living thins. Ask the students why you refrigerate milk. Does it keep indefinitely even when refrigerated? The point is that cold temperature slows down the growth of bacteria that cause milk to sour.

7. Compare Henry Gibson's "Declaration of Dependence" to the Declaration of Independence.

DECLARATION OF DEPENDENCE

by Henry Gibson

I am a part of nature.
I am a part of everything that lives.
I am bound together with all living things
in air, in land, in water.

My life depends on nature
Upon its balance, upon its resources,
And upon the continuity of both.

To destroy them is to destroy myself.
As a member of the human race
I am responsible for its survival
I am a part of nature.
I will not destroy it.

Discuss the importance of each of these declarations.

8. Scrambled Puzzle

Unscramble these six scrambles to form six ordinary words.

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_____RAI

_____TWERA

_____TPALNS

_____GLITH

_____LIMASNA

_____UNS

Now unscramble the six circled letters to find the answer to the cartoon.

(Picture of a natural scene)

Man is a part of it.

(Answer: Nature)

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SELF-TEST

Please complete this self-test. Check your answers on the next page.

1. In an aquarium, which organisms produce oxygen?

2. List three abiotic factors of the environment.

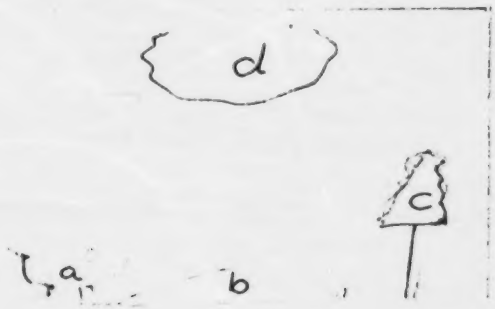
a. ----------

b. ----------

c. ----------

3. Why are decomposers necessary for life on earth?

4. A water molecule is part of the abiotic environment when it is in:



a. ---- b. ---- c. ---- d. ---- (Check all that apply.)

5. Diagram the water cycle as it would appear if there were no living things.

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ANSWERS TO SELF-TEST

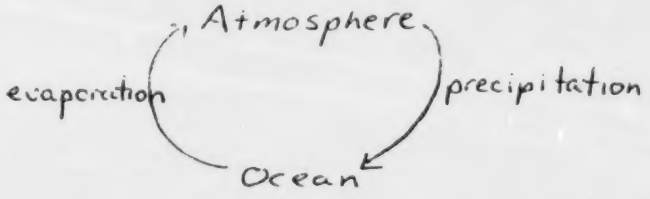
1. Aquatic green plants such as Elodea and Sagittaria produce the oxygen in an aquarium. Green plants are the only organisms capable of photosynthesis.

2. Abiotic factors include air, water, light, and temperature. They do not include food, parasites or other living or formerly living entities.

3. Decomposers keep matter cycles. Without decomposers we would be knee-deep in dead plants and animals.

4. The water molecule is part of the abiotic environment when it is in (b) a body of water and (d) the cloud or atmosphere. It is part of the biotic environment when it is in a plant or an animal.

5. If there were no living things the water cycle would appear like this:



If you had difficulty answering these questions you may wish to review tape #3. Otherwise go on to module #4.

MODULE #4: ADAPTATIONS IN LIVING THINGS

Plants and animals are adapted to carry on their life functions in a particular biotic and abiotic environment. There is a wide variety of adaptations among living things.

Some adaptations are useful in getting food. Others help the organism protect itself from enemies. Still other adaptations ensure successful continuation of the species.

Listen to tape #4 for a discussion of some of the ways in which organisms are adapted to survive in their environments.

TAPE #4: ADAPTATIONS IN LIVING THINGS

The structure of an organism is adapted to fit its particular life style. For example, the feet, wings, tails and beaks of birds are adapted for special ways of catching food, eating, swimming and perching.

Consider these feet. A robin perches on branches. The three toes in front and one behind are a good arrangement for grasping a branch.

A duck has long, webbed toes for swimming.

An eagle has powerful claws or talons on his toes. These are useful for grabbing prey animals.

A crane has long legs and separate toes for wading.

A woodpecker has two toes in back, and two in front. This is good for climbing trees.

Bird beaks are specially adapted for food getting.

A hummingbird has a long thin beak for getting nectar out of flowers.

Eagles have hooked beaks for tearing flesh.

Herons have long beaks to help search for food in the mud.

A sparrow has a short, heavy beak for crushing seeds.

A duck has a wide flat beak with notches for scooping up and straining foods.

Wings are specially adapted to fit the kind of flying that a particular kind of bird does.

Robins have short, broad wings that enable them to

maneuver quickly.

Penguins have paddle-like wings for swimming.

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A gull has long slender wings for gliding.

A hawk has long broad wings for soaring.

Structural adaptations in insects are also quite evident. Their bodies are well-suited to the types of lives they lead. For example, look at some representative mouthparts.

A grasshopper has strong, hard mouthparts. This arrangement is useful in biting and chewing leaves.

A butterfly has a long coiled proboscis for reaching deep into flowers. This enables the butterfly to reach the nectar.

A mosquito's mouthparts form a long piercing tube. The mosquito uses this to lap up blood from its host.

Plants and animals have adaptations to their abiotic environments, too. Where water is a problem, organisms have evolved ways of coping with the shortage.

Many desert plants such as cactuses have root systems just below the surface. When it rains, the roots quickly absorb the water. These same plants often have barrel-like stems to store this water. Cacti also have very small leaves. The small surface area of these leaves (or spines) cuts down on the amount of water loss due to evaporation. The leaves of desert plants are often waxy, which further reduces the water loss.

Desert animals are also adapted to conserve water. Desert rodents get along on the water in the food they eat. Many desert animals are active only during the night when

temperatures are lower.

In temperate deciduous forests, such as those in the eastern part of the United States, plants and animals must be adapted to survive seasonal changes. In winter, most of the water is frozen and therefore unavailable to plants. Deciduous trees like oaks and maples lose their leaves in the autumn. This cuts down on the loss of water from the trees. Evergreen trees such as pine and spruce have thick waxy coatings on small leaves. This makes water loss less of a problem for them.

Animals must be adapted tc survive the food shortage that winter entails. Many birds migrate thousands of miles to places where food is plentiful.

Some animals such as the chipmunk accumulate enough food in the autumn to last them all winter.

Other animals hibernate. Their body processes slow down considerably. As a result the animal conserves energy and can live without eating for a long period of time.

Thus far we have been talking about cases where a particular structure is adapted for some particular purpose. Sometimes the entire appearance of an organism is a protective adaptation.

For example, some organisms are able to blend in with their environments. This is called camouflage. Ptarmigans are white in the winter and brown in the summer. Thus these birds are camouflaged, making it hard for enemies to find them.

A chameleon has the ability to change its coloration to blend in with its surroundings.

A praying mantis is leaf-colored. When it stands still in the midst of foliage it is very hard to find.

One butterfly looks like a dead leaf.

The walking stick looks like a small twig.

Many adaptations involve the behavior of organisms as well as their appearances.

Male birds are often brightly colored and go through elaborate courtship dances. These two kinds of adaptations, one structural and one behavioral, have the result of attracting mates. This helps ensure survival of the species.

Female birds incubate their eggs and feed and protect the newly hatched young. These, too, ensure the survival of the species.

Please turn to the workbook for ideas on teaching these concepts to your students.

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ADAPTATIONS IN NATURE

1. Get in the habit of focusing student attention on adaptations of plants and animals. Examples abound. A snail in the class aquarium, a dandelion, a mosquito, lichen on a rock, a grasshopper, a maple tree, a dog, -any living thing at all can serve as the subject. Ask how its structure and/or behavior helps it to survive. Comparing two organisms is a good way to get at special adaptations. For example, consider how a dog's teeth are different from a man's teeth.

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ASSIGNMENT 6

Choose any five organisms and briefly tell how each is adapted for survival in its environment.

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2. Social behavior is an example of an adaptation within a species rather than in a single organism. The social behavior of ants and bees can be studied. The concept can also be extended to include cultural adaptations of man. Water purification can be considered an adaptation for survival, as can laws and treaties.

3. Set up a bird feeder. This will bring many birds into close range so the students can see structural adaptations for themselves. The class may want to experiment with different

designs to see which are best for attracting birds. This is a good way to integrate art with ecology.

4. Camouflage

This series of activities provides a way of integrating some mathematical concepts with the concept of adaptation. First do a little work on probability.

a. Flip a coin.

Let the students try to guess whether it is heads or tails. Flip it several more times. Establish the idea that it is sometimes heads and sometimes tails, but in any single flip you cannot tell which it will be.

b. Multiple flips

Ask the students to guess how many heads would appear if you flipped a coin twenty times. Test this out by having the students flip coins. Divide the class into pairs. Student A flips a coin ten times while student B records the results. They should then reverse roles and flip the coin another ten times. At the end of this have each team add up the total number of heads and the total number of tails. Have each pair of students write these totals on the blackboard

PAIR	HEADS	TAILS	TOTAL
1	9	11	20
2			
3			

4

.

.

.

--- --- --- ---

GRAND TOTAL

You will notice that very few if any of the teams got exactly ten heads and ten tails. However, chances are good that most of them got totals fairly close to ten and ten.

Now add up the heads, tails, and grand total. Point out to the students that the number of heads is approximately equal to the number of tails. Any deviations were due to chance.

c. Is this chance?

Tell the students you flipped a coin two times and got heads each time. Does that mean anything is wrong with the coin? Establish the idea that this could well be due to chance. We are not surprised.

Similarly, if a mother and her neighbor both had baby boys you would not be surprised. That can happen often.

Now what about if you flipped a coin two hundred times and got heads each time? Establish the idea that this is probably not due to chance alone. You would be very surprised if that happened. You would probably suspect that the coin

was weighted funny or both sides were heads. In a similar way, we would be very surprised if every pregnant woman in town delivered a baby boy.

d. Toothpicks

When the students are not around, paint fifty toothpicks green and fifty other colors. When they are dry, scatter the toothpicks in a delimited grassy area. Give the class about fifteen seconds to pick them up.

Bring these toothpicks back into the classroom. Separate them into green and not green. There will undoubtedly be fewer green. Record the totals on the blackboard.

Go back outside and search the area until all one hundred toothpicks have been retrieved. Go back into the classroom and prove to the students that half the toothpicks were green.

e. Chance

Show the students what would happen by chance. Put thirty green toothpicks and thirty of other colors in a paper bag. Have a student close his eyes and pick out twenty toothpicks. Approximately ten will be green. Repeat the process with several other students. Establish the idea that chance alone would not account for what happened outside.

How can the results of the out of doors experiment be explained? Someone will probably come up with the idea that the green ones were harder to see because they blend in with the grass. Challenge them to test this hypothesis at home.

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f. Home assignment

This would be a good place to give the students some real choice. It is likely that many students will want to try an experiment with their parents, but it is not essential that everyone do it. Let this be a non-standardized assignment. The students should devise their own ways of testing their hypotheses and report back the next day.

5. Camouflage in Nature

Introduce the word camouflage and discuss some examples. Perhaps take a nature walk specifically to look for examples of camouflage. Relate camouflage in nature to man's attempts at camouflage such as in warfare.

6. How Animals Protect Themselves

Camouflage is only one of many means which animals have of protecting themselves. For example, porcupines, skunks, and turtles use three other means of protection.

Have the students take turns pantomiming ways in which animals protect themselves. The student who guesses correctly gets to go next.

This is the end of module #4. Go on to module #5.

MODULE #5: SEED DISPERSAL AND SUCCESSION

In the last module you were asked to choose five organisms and tell how each is adapted for survival. It is likely that you thought of animal adaptations. The word "organism" and the term "living things" usually makes us think of animals. But plants are living organisms, too, and they have a variety of specialized adaptations for survival.

Please listen to tape #5 for a discussion of adaptation in one group of plants.

TAPE #5: SEED DISPERSAL AND SUCCESSION

An interesting diversity of adaptations occurs in seed-producing plants. Many plants are specially adapted for getting their seeds spread out over a wide area. There is a good reason for this. If all seeds fell right next to the parent plant they would be unable to compete with the larger plant.

The solution that has evolved over a long period of time is to produce a huge number of seeds and to disperse them widely. Many of them will never grow. But some will wind up in suitable places and germinate.

People who are maintaining lawns are quick to pull up dandelions before they have gone to seed. When mature the yellow flower will turn into a cottony puff of seeds. These get picked up by the wind and carried to all parts of the lawn. Wind is a major agent of seed dispersal.

Milkweed is another example of a wind-carried seed. When ripe, the pod splits open and releases a cloud of tiny white seeds.

Maple seeds are adapted for wind dispersal. These winged seeds twirl around in the breeze like helicopters. In that way they are carried very large distances.

Grass seeds are very lightweight and therefore well-suited for being carried in the wind.

Tumbleweed rolls across the land as the wind blows, scattering seeds all around.

A second major agent of seed dispersal is animal life. In the autumn squirrels scurry around picking up acorns and

nuts and burying them. Some of these are forgotten, and lie in the ground until proper soil conditions allow them to germinate.

Some seeds have burs which help them attach to animals that brush by. Thistle plants are among the many which disperse seeds in this way.

Birds and mammals are attracted to brightly colored fruits. When the fruit is eaten, some of the seeds will pass through the animal undigested. The seeds may germinate if dropped in a suitable place.

A third mode of dispersal is by water. A notable example is the coconut. The whole fruit is shown in b. The seed, the inside part that contains the milk, is shown in c. The fruit can float undamaged for a long time. If it reaches land and cracks open the seed may be able to germinate and grow into a new coconut palm tree.

So far we have been talking about the various ways in which seeds are dispersed. But getting spread far and wide is only part of the process completed. In order to produce a new plant the abictic conditions must be suitable for germination of the seed. After germination, the conditions must be right for the growth of the plant or it will not survive. The wind may scatter grass seeds onto a desert, but that wil not result in a field of grass. Orange seeds may do well in Florida, but will have little lasting success in Minnesota. A seed falls in an area where there are already other plants growing. The new plant will replace an old one only when it is better suited for a particular environment than the original inhabitant.

The concept of adaptation can be used to explain the sequence of changes that occur in a community. For example, over a period of time a lake community may gradually change into a forest community, or a grassland may turn into a desert area. The process by which a community changes is called succession.

Consider the following example of succession. It starts with a farm in upstate New York. The surrounding area has a wide variety of plants - grasses, shrubs, many kinds of trees. For several years the land had been used for growing crops. When the farm was abandoned a series of changes was begun.

The crop plants could not compete with the grasses. With no one to control the weeds, the grasses took over. Soon the area was a grassy field.

The first trees to get a foothold were the pine, birch and poplar trees. These trees were favored because they can

tolerate direct sunlight.

As these first trees grew they began to provide shade. Soon red oaks, red maples, and tulip trees were able to grow. They were better adapted to the new, shady environment, and they soon crowded out the sun-loving trees.

Eventually the oak, maple and tulip trees became so big that their shade was too dense for their own seedlings to survive. Shade-tolerant trees such as beech and sugar maples were able to grow and they soon took over.

The beech and maples constitute a climax community for that area. The beech-maple forest will remain unless there is a large change such as a new ice-age or a forest fire.

In a similar way, the process of succession may change a lake community into a forest community. Here is how it might happen.

A fast moving stream empties into a lake. The rapidly moving water contains a lot of sediment. This now settles into the lake.

Gradually more and more dirt is deposited. The lake gets smaller and shallower.

Soon there is no lake at all. In its place there is a swamp.

As the swamp plants die and decay, they become part of the soil. The amount of water in the swamp decreases.

Eventually the swamp plants will no longer be able to survive in the drier soil. Grasses and small trees will grow in their place.

The small trees provide shade and thus crowd out the grass and other plants that need a lot of sunlight.

Eventually large trees such as the beech and maple will take over. As in the last example, this is a very stable community.

The third example of succession to be discussed is called bare-rock succession.

This road was built by cutting through a mountain. Bare rock was exposed.

The rock does not remain bare for long. Tiny lichen plants begin to grow on the rock. The lichen are the pioneer community - the first living things to take hold.

As the lichen grows it cracks the surface of the rock. Decaying lichen help to build up soil in these cracks.

With a little soil, moss plants are able to grow on the rock. They in turn die and decay, forming richer soil.

Larger plants can then take hold. First the grasses..

Then shrubs and small trees...

And finally the larger trees take over.

Please turn to the workbook for ideas on teaching about seed dispersal and succession.

IDEAS FOR TEACHING ABOUT SEED DISPERSAL AND SUCCESSION

1. In 1964 careless people caused a forest fire which destroyed all of the plants in a large area. The area was closed off. No people were allowed in. A few years later a ranger went back to the area and found the following kinds of plants:

    1. oak trees
    2. maple trees
    3. dandelions
    4. grass
    5. apple trees
    6. blueberries
    7. thistle
    8. milkweed

Have the students try to explain how each of those plants might have gotten there.

2. Field trip on seed dispersal

Instead of activity number one, or perhaps in addition to it, take the students outside to look for evidence of seed dispersal. Choose a time when many of the plants are in seed. Tie a numbered cloth on each of several selected plants. It is not essential for you or the students to know the names of these plants. It is perfectly okay to refer to them by number. Try to choose plants that are dispersed in a variety

of ways. This activity will show the students that you can learn a lot about nature by observing it. It is not necessary to know all the names.

3. Use this story in class.

A man sailed a bathtub from California to Hawaii. He stopped for a few days at an uninhabited island. While looking arcund for things to eat he found some delectable berries, but he could not find a single coconut. Since coconuts were a favorite food of his he combed the island looking for them. But to no avail. There was not a single coconut on the entire island.

Fifteen years later he came back to the same island. This time there were lots of coconuts. The man was delighted, but perplexed. How did the coconuts get there?

If you know of anyone going to Hawaii, ask him to bring back a whole coconut fruit. (The part in the grocery store is just the seed.) Demonstrate that the fruit floats.

This is the end of module #5. Please go on to module #6.

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MODULE #6: FOOD CHAINS AND ENERGY PYRAMIDS

For a long time Americans have expected their neighborhood supermarkets to be stocked with high quality, low cost foods. There are signs that these expectations may be changing. In recent months, food shortages and rising prices have caused many people to stop taking food for granted. This module is concerned with some of the ecological concepts involved in feeding man and other organisms.

Please listen to tape #6: Food Chains and Energy Pyramids

TAPE #6: FOOD CHAINS AND ENERGY PYRAMIDS

You will recall that an ecosystem is made up of plants and animals and the environment in which they live. Green plants are the most important organisms in an ecosystem. Only green plants are capable of photosynthesis. Recall that the process of photosynthesis uses sunlight, carbon dioxide and water to produce food and oxygen.

Green plants, then, are the producers in an ecosystem.

All other organisms in an ecosystem are called consumers. They cannot produce their own food, and therefore must get their energy by consuming other living things.

A fox eats a rabbit which ate some lettuce. This is called a food chain. It is a description of how energy passes through the ecosystem.

All food chains begin with a producer, that is, a green plant that produces food by the process of photosynthesis.

An organism that eats a green plant is called a primary or first-order consumer.

The fox ate the rabbit which ate the lettuce. This makes the fox a second-order consumer in this food chain. A second-order consumer is an organism which eats a first-order consumer.

If a mosquito were to bite the fox, the mosquito would be a third-order consumer.

All living things are part of food chains. When you eat a steak you are a second-order consumer. The food chain looks like this. The grass is the producer, the cow is the first-order consumer, and you are the second-order consumer.

When you eat cereal or an apple or green peas you are a first-crder consumer. Any time you eat a green plant directly you are being a first-order consumer.

Some animals, such as the rabbit, eat only green plants. Rabbits, therefore, are always first-order consumers. Other organisms, such as man, sometimes eat green plants, and sometimes eat other animals.

Organisms may be part of several different food chains. These interlocking food chains make up what we call a food web. An example of a food web is shown in picture .

In this food web the cricket is a first-order consumer. What other organism is a first-order consumer in this food web? (Pause.)

The answer is the field mouse. The field mouse is a first-crder consumer because it is eating a producer.

The snake eats both frogs and field mice. What role is the snake playing in each case? (Pause.)

The snake is a second-order consumer when he eats the field mouse, and a third-order consumer when he eats the frog. The two food chains look like this:

Some of the longest food chains occur in aquatic ecosystems, where little fish are eaten by bigger fish, which are in turn eaten by still bigger fish.

We have already seen that every food chain begins with a green plant. Food chains end with decomposers, such as bacteria of decay. These decomposers return materials to the air and to the soil so they can be reused.

A food chain can be used to trace the flow of energy in an ecosystem. A green plant captures energy from the sun and

converts it to the chemical energy of food. When a rabbit eats lettuce he is getting some, but not all of the sun's energy that was trapped by the green plant. Some of that energy was used up by the plant itself while it carried on its life processes.

When a fox eats a rabbit he is getting only some of the rabbit's energy. Much of the rabbit's energy was dissipated in maintaining the rabbit. This energy relationship can be shown by using diagrams such as the one in the picture. This type of figure is called an energy pyramid. It illustrates the fact that that it takes a lot of energy at one level to sustain the next level.

For example, consider a man eating bass from a lake. The food chain might be algae - water flea - minnow - bass - man. In that case, 10,000 pounds of algae might have been needed to produce one pound of man.

Please turn to the workbook for some ideas on using these concepts with your class.

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TEACHING SUGGESTIONS:

FOOD CHAINS AND ENERGY PYRAMIDS

1. Food chains

The concept to be studied is that all food energy comes from green plants. Introduce the notion of a food chain by using an example such as: The beef we eat comes from cows. What did the cows eat? draw a couple of food chains on the blackboard. Ask the students to construct food chains for a few of the foods they ate that morning or at dinner the night before. Some possible food chains are:

For cheese man → cow → grass

For bread man → wheat plant

For chicken man → chicken → corn plant

For a hamburger man → cow → grass

2. Food energy

Ask students to guess how many pounds of food they eat in a year. Keep a record of the guesses. Then do some mathematical work based on food consumption.

You might have several students list everything they eat on a particular day, complete with quantity measures. Then assign members of the class to find out the weights of these foods. Many of the weights can be estimated by going to the

grocery store. For example, if there are three tomatoes in a one pound package you can estimate the weight of a tomato as five or six ounces. Liquids can be approximated as sixteen fluid ounces equal to one pound. Encourage the students to get help from their parents in estimating the weight of the food they consume.

Ask the students to find the average weight of food each consumes in a single day. Then have them compute the number of pounds of food they eat in a year. Obviously this will be a very large number.

Now ask a student, preferably not a chubby one, if he gained that number of pounds last year. Why not? The students will have various ideas. Among the true reasons are:

a. You burn up a lot of this food in your daily activity. Just keeping your body processes going requires energy. Point out to the student that the calorie is a measure of the amount of usable energy in food. Some foods have more usable energy, and therefore more calories in a given weight.

b. Some things we eat we cannot digest. That is why foods like celery are good for dieters. Our bodies get only a few calories from celery. The rest is eliminated in the feces.

c. Foods have a lot of water in them. Some of this is lost when we breathe, perspire, and urinate.

3. Energy expenditures

Discuss the relationship between calorie consumption, exercise, and weight gain. Every 3600 calories is equivalent to one pound of weight gain. Discuss the various amounts of energy expenditures in activities such as walking, swimming and running.

Energy Expenditure	(Calories per hour)
sleeping	65
sitting at rest	100
walking leisurely	140
light exercise	170
walking briskly	250
swimming	500
running up stairs	1000

4. Get an estimate of how much food one student may have eaten in his lifetime. You already have an estimate for this year. (from activity 2) Let the students decide how much smaller to make the estimate for the first, second, and third years of life, etc. Get a total. It took this total amount of food to produce 80 pounds of person (or 90 or 70 - whatever seems like a good estimate of an average student's weight.) Point out that these are all estimates. They may be in error by a considerable amount, but they still give you some idea to work with.

Using a piece of graph paper, draw a bar graph to

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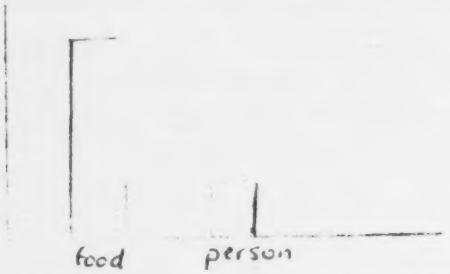
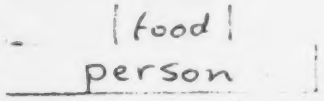
represent the situation. It will look something like this:

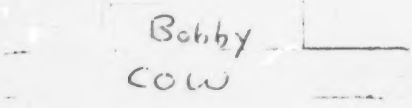


Show them that we can represent the same thing in another way.



The shaded area represents the amount of energy that has been lost.

Ask some students to name particular foods that they like. Choose one of these foods to use as an example in the rest of this activity. For example, suppose the food was ice cream. Ask the students what living thing is responsible for giving us that food. Redraw the pyramid as follows:



Now ask what the cow ate. When they come up with an answer such as grass, ask them where to put the grass box and how big it should be. Establish the idea that the cow burned up some of the food energy in staying alive. It takes energy to breathe, circulate blood, swish his tail, etc.

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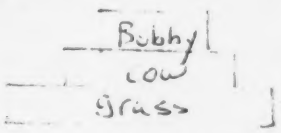
Show the students how to estimate the size of the grass box by using proportions. If the total was 15,000 pounds of food tc produce 90 pounds of Bobby, then

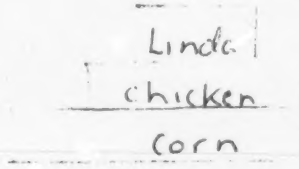
$$\frac{90}{15{,}000} = \frac{15{,}000}{X}$$



Bobby got his energy from cows, cows got their energy from grass. Where did the grass get its energy?. If noone knows, be sure to point out that green plants use the energy from sunlight to make food. Remind them of the activity where the plant in the cabinet was dying from lack of light. only way living things get energy is from the sun. Plants get this energy directly from the sun, and animals get it from eating plants or cther animals.

4. What should man eat?

Give an example of an energy pyramid such as the one below:



Tell the students that this amount of corn could have produced a lot more pounds of girl, in fact enough for Linda and Carol and John and Bill and quite a few others. Help them to figure out that if we eliminate the chicken step and feed the corn directly tc people we would lose less energy.

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This is why meat is such an expensive food source. In many parts of the world most people cannot afford to eat very much meat. The more people there are in the world the harder it will be to feed them. That is the reason for the suggestion that we switch to meat substitutes such as soybeans.

5. Alternative foods

If you and the students are interested you might look into meat substitutes and alternative sources of protein. For example, the recommended daily allowance of protein for a ten year old is forty grams. You can get forty grams of protein by eating eleven ounces of hot dogs (at a cost of about eighty-five cents) or five ounces of peanut butter (at a cost of about twenty-five cents).

Some grocery stores sell a ground beef and soybean mixture to be used for hamburgers. You might visit a health food store or get some recipes for dishes starting with soybeans, chickpeas, or cracked wheat. Parents might be persuaded to cook some of these for the class to try. The class might enjoy making granola, a tasty and nutritious

mixture of grains, nuts, raisins, and honey.

You might try planning a meatless meal from more traditional foods. The school dietitian might be willing to help out. Otherwise you can consult a book on the basic food groups and the essential vitamins. A vegetarian might be an interesting visitor to the class.

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SELF-TEST ON FOOD CHAINS AND ENERGY PYRAMIDS

Please complete questions 1-6. The answer key is at the end of the module.

1. An example of a community that produces very little of its own food would be found in a

a. pasture
b. meadow
c. forest
d. cave

2. A man buys 1000 pounds of corn meal. He wants to provide as much food energy as possible to his family. Would his best course of action be

a. to feed the corn directly to his family

OR

b. to feed the corn to the cows and then feed beef to his family?

Explain.

3. Corn Plant > insect > bird > snake

a. This diagram is called a ----------.
b. The role of the corn plant is ----------.
c. The third-order consumer is ----------.

4. What role is man playing when he eats

a. broccoli?

b. steak?

5. What does the phrase "All flesh is grass" mean?

6. Which of the following are necessary for photosynthesis to take place?

carbon monoxide, carbon dioxide, chlorophyll, hydrogen peroxide, oxygen, sugar, sunlight, water.

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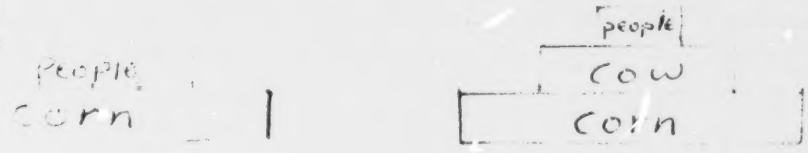
ANSWERS TO SELF- TEST

1. A cave community would not produce its own food. Producers need light in order to carry on photosynthesis.

2. Corn meal fed directly to people would result in the most food energy for them. Compare the two energy pyramids. The more levels in the pyramid the less energy reaches the top.



3. This is a food chain. The corn is a producer. The third-crder consumer is the snake.

4. Man is a first-order consumer when he eats broccoli and a second-order consumer when he eats steak.

5. The phrase "All flesh is grass" refers to the fact that green plants are the beginning of every food chain. Everything we eat is from a plant either directly or indirectly.

6. The requirements for photosynthesis are carbon dioxide, water, sunlight, and chlorophyll.

If you need more work on food chains you should review the tape. Otherwise go on to module #7.

MODULE #7: PLANTS AND MAN

A popular bumper sticker a few years ago asked, "Have You Thanked a Green Plant Today?" Its purpose was to remind us that each of us, from unemployed worker to wealthy executive, is completely dependent upon nature. Without other living things man would find it impossible to get food, oxygen, clothing, and shelter.

Please listen to tape #7.

TAPE #7: PLANTS AND MAN

We depend on plants for a lot of reasons. You have already learned that plants are essential because they produce food and oxygen. Now we will look more closely at the uses which man makes of plants.

A typical green plant consists of four main parts: the roots, stem, leaf, and flower. Man has found uses for these plant parts - for food, for clothing, for medicine, for shelter, and for decoration.

The stem of a plant has various uses. Potatoes, asparagus, and celery are all plant stems.

Cough syrups are made from the bark of cherry tree.

Linen comes from the stem of the flax plant.

Quinine, used to treat malaria, comes from the bark of the cinchona tree.

And, of course, the woody stems of trees are used for making lumber, furniture, paper and many other things.

Roots are useful to man. Carrots, turnips, sweet potatoes, beets, and radishes are all plant roots.

Licorice and ginger are root products used in making candy.

Among the useful leaves are lettuce, cabbage, spinach, and parsley.

Spearmint, peppermint, sage, and thyme are also plant leaves.

In tropical areas of the world, palm and grass leaves are used to cover the rooves of homes.

The flowers of green plants are also useful to man. For

decorative purposes,

For perfumes,

And for dyes.

In addition, flowers produce fruits and seeds which are important food sources.

A seed contains the embryo of the new plant. It may lie dormant for a long time, until, with proper moisture, it will germinate and grow into a new plant.

You have been provided with a peanut in a shell. The shell is the fruit or ripened ovary of the peanut flower. Crack it open to reveal the peanuts, or seeds. The thin coating on the peanut is called a testa or seed coat.

Break one of the peanuts apart. The two halves are called cotyledons. The cotyledons contain the stored food which the new plant would use until it started making its own food.

Notice the embryo in between the two halves of the seed. Some people think the embryo looks like a miniature Santa Claus.

You can watch peanuts and other seeds germinate in the classroom. There are a variety of methods for doing this, and several of these methods will be described in the workbook.

You may actually want to grow fruits and vegetables from seeds. In that case it is probably time to shatter one of your childhood myths. Squash is a fruit. So is a cucumber. Rhubarb is a vegetable. Surprised? The scientific definition of a fruit is the part of the plant formed from the ovary of the flower. If a plant part contains seeds it is a fruit. Therefore, peanuts, tomatoes, cucumbers, squash, green

peppers, apples and peaches are all fruits.

Foods from other parts of the plant do not contain seeds and are called vegetables. Lettuce, cabbage, broccoli and carrots are examples of true vegetables.

There are many interesting activities you can do with seeds and grown plants in the classroom and outside the classroom. Please turn to the workbook for some ideas.

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TEACHING SUGGESTIONS: PLANTS AND MAN

1. Growing Plants in the Classroom

Elementary school students can enjoy planting seeds and watching them grow. There are several ways of growing seeds. Each has its advantages and disadvantages. You will have to decide which method(s) best suit your purposes.

a. Clear Container and Blotting Paper

You can watch seeds germinate if you plant them in a clear container such as a jar. Line the jar with a piece of blotting paper. Place the seed between the jar and the blotting paper. Stuff cotton into the center of the jar to keep the blotting paper against the sides of the container. Put water in the jar to cover the bottom one-half inch of the blotter. The blotter will act as a wick, drawing up water to the seed. Add water as needed. The seed will germinate and the plant will begin growing. However, it will not live indefinitely unless it is transferred into soil.

b. Paper Cups with Soil

Put soil into paper cups. Plant one or two seeds about one-half inch deep. Water as needed.

This method has the advantage of using paper instead of the more dangerous glass. It has the disadvantage of obscuring the view of the germination process.

c. Petri Plates with Filter Paper

Line the bottom of a petri plate with filter paper. Wet the paper and spread several seeds over the surface. Cover the plate, lifting only to water as needed.

One special trick: Try cutting colored construction paper to fit the dish, and using it instead of filter paper. If you then plant radish seeds the students will be able to see the tiny white root hairs. If possible let them examine the radish roots with a hand lens or magnifying glass.

d. Peat Pellets

Get some peat pellets from a garden supply store. Ask the students to bring in empty large cans. Moisten the peat pellet. After several hours it will have swelled up enough to use.

Plant a few seeds in each peat pot. Place the peat pots on a large dish, cover with wax paper or plastic, and place in a window. Keep the pots moist by watering as needed. The pots should be kept covered until the seeds have germinated.

When the plant has some leaves it is ready to be planted in a larger container. Punch holes in the bottom of the can. These will permit proper drainage. Add soil to the can, and transfer the peat pot containing the plant to the can. Keep the plant in sunlight, and add water as needed.

If you have a garden, you can plant the peat pots directly in the garden rather than in cans.

2. Let the students bring in seeds they want to see grow. Let them bring in everything and anything that is a seed, including grapefruit, apple, lemon, peach, squash, melons, beans, peas, corn, etc. If they wish they can try to germinate seeds from plants in the area - maple seeds, acorns, hickory nuts, etc.

Avocados are especially fun to grow. Stick some toothpicks in the seed and suspend it in a glass of water. It may take several weeks to germinate. Once it has a good root system it can be transplanted tc a pot of soil.

3. If the students enjoy working with plants you might go further. Try growing new plants <u>without</u> seeds. Onion bulbs, potatoes, and cuttings from house plants are all possibilities.

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ASSIGNMENT 7

Most green plants are made up of roots, stems and leaves. Give two examples of uses man has found for each of those plant parts.

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4. Man's dependence on plants

a. Give the students the following assignment. "Your mother is getting ready to cook a very special dinner. On the table in front of her are the ingredients:

1. turkey
2. cranberries
3. pumpkin
4. flour
5. lettuce
6. tomatoes
7. potatoes
8. milk
9. salt
10. pepper

Which of these items came from plants? Which depended on plants but not directly? Which items cannot be traced back to plants?"

(The answers are: Came directly from plants - 2,3,4,5,6,7, and 10. Can be traced back to plants - 1, and 8. Cannot be traced back to plants - 9.)

b. Imagine a morning scene in a typical American household. There is a table, napkins, salt and pepper shakers, silverware, bacon and eggs, toast, orange juice, coffee, sugar and cream. For each of those items, show how it can be traced back to plants. Which items cannot be traced back to plants?

5. We depend on plants for many things. Have the students list three objects that would not be in the classroom if there were no green plants in the world.

(Some possible answers might be the wooden desks and

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chairs, paper, rubber erasers, cotton clothing, and people.)

6. Importance of Plants Plants have always been important to people. At different times and in different places plants have been used in different ways. Assign groups of students to workon the following topics, or let the students pick one of these topics to work on.

a. Parsley, Sage, Rosemary, and Thyme: Plants for Flavoring Food

b. Plants for medicine - past and present

c. From Fig Leaf to Granny Dresses

d. Grass Huts and Log Cabins: Plants for Shelter

Each group should report back to the class.

7. Assign Swiss Family Robinson to the class. Discuss the various ways in which man is dependent on nature.

8. Let each student pick one plant that will be his for the year. Take the class outside at least once a month. Each person will go back to that same plant and record information about it, in words and in pictures. Such information might include the name of the plant if he knows it. Ask for volunteers each month to tell about their plants. What happened to the plant in the winter? Did you see any seeds? When? Was there any evidence of animals eating it? Any evidence of growth? Of disease?

Was there any noticeable difference after a dry spell? After a rain? Does the plant look very different in April from the way it looked in January?

Have each student write a story about how it feels to be his plant. Ask each student to tell the class about his plant without using words. The report may take the form of a picture, a dramatization, a dance, or anything else the student thinks of.

This exercise has a number of important purposes. It will teach the students to observe living things closely. Among the ecological concepts they should learn from this are that living things change, the abiotic environment influences living things, and living things are adapted to their environments.

This concludes module #7. Please go on to module #8.

MODULE #8: MAN AND ECOSYSTEMS

"Support Your Ecosystem, It Supports You."

Many cars carry this message on their bumpers. Man is dependent on nature, although we sometimes act as if we thought otherwise.

Listen tc tape #8, "Man and Ecosystems" to find out what may happen when man interferes with nature.

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TAPE #8: MAN AND ECOSYSTEMS

Think about insects for a minute. Most people think of something negative. Insects annoy us. Locusts eat our crops, aphids ruin our roses, moths ruin our clothing, and mosquitos torment us. The list can go on and on. It seems like the world would be a better place for man if there were no insects. Or would it?

Butterflies, moths, and bees are essential for the pollination of many flowers. Without these insects many plants would not reproduce as well. Some plants would not be able to reproduce at all. Since green plants are at the base of every food chain, the balance of nature would be considerably upset.

Even the bothersome mosquito has a vital place in nature. Mosquitoes are important in the aquatic food webs that provide man with fish for dinner.

Somehow man is able to forget the benefits of insects, but we cannot forget their harm. In some cases we have declared all-out war against insects. The result can be worse than whatever it was we were trying to cure.

Pesticides are a good case in point. Before we started frequent use of DDT it was an effective pesticide. For example, most mosquitoes could be easily killed by DDT. A very small percent of the mosquito population had a genetic make-up that made it resistant to DDT. As we used more and more DDT we killed off all but the resistant mosquitoes. Now we have a population of mosquitoes which can only be killed by a massive dose of DDT.

Meanwhile the DDT has had some rather deleterious side effects. Our aim was to get rid of a troublesome organism, but we got rid of helpful organisms at the same time. Bees, butterflies, and other helpful insects were killed by DDT, although that was not the intent.

Neither did we intend to harm the bird populations. Many birds aid farmers by eating insects that would otherwise eat the crops. Other birds keep mice and rat populations in check. But DDT has harmed many birds. In some cases it affects the shells of the eggs. The shell may be so thin that it cracks when the mother tries to incubate it, thus killing the baby bird. In some cases DDT has completely stopped the reproduction of the species. All of these changes affect the balance of nature. Without intending to, man has drastically disrupted ecosystems by using pesticides.

Insects are but one class of organisms that man would just as soon do without. We have waged war against another group of organisms - the predators. Predators seem evil to many people. Foxes kill our chickens. Coyotes sometimes kill our cattle and sheep. When we watch television specials we are likely to root for the baby monkey to escape from the stalking tiger. Man often forgets that all living things are integral parts of ecosystems. Predators are an essential part of the balance of nature.

Here is a good example of what may happen when man tries to eliminate predators. Prior to 1900 the Kaibab Forest in Arizona was a beautiful well balanced community of pine, spruce, and fir trees. Chipmunks and squirrels were abundant. Many species of birds used the forest for food and shelter.

About four thousand mule deer browsed in the area.

The forest was also the home of a variety of predators including bobcats, timber wolves, mountain lions, and coyotes. Indians used the forest as a hunting ground. They killed deer to get meat for food and skin for clothing. Without outside interference the Kaibab forest would likely have remained thriving and beautiful for a long time. But that was not to be.

In 1906 the Kaibab forest was made a national game preserve. The government wanted to increase the number of mule deer in the preserve. Therefore deer hunting was prohibited. Moreover, a systematic attempt was made to eliminate all of the animals which prey on deer. Over six thousand predators were killed in the next twenty-five years. Without natural enemies, the aged and the sick deer were not culled. As was intended, the deer population increased rapidly.

By 1920 there were signs that something was amiss. The young trees and shrubs that the deer used as food were becoming scarce. But noone heeded the warning.

Government hunters continued to kill the predators. The deer population rose to almost one hundred thousand. This huge population needed a lot of food. Before long every shrub was picked clean of leaves. Trees were denuded up to the level the deer could reach.

Belatedly hunting was again permitted, and this helped to lower the deer population. But it was not enough. Without adequate food, thousands of deer starved, or became so weakened that they were killed by disease. By 1942 there were

only eight thousand deer, and these were underfed and unhealthy. The plant life had suffered tremendous damage in this time. Some species had disappeared entirely. Others, such as the cliff rose, seemed to have stopped reproducing. The deer had thinned out the forest by consuming so many shrubs and trees. Without competition, some grasses which deer do not eat began to thrive. The total ecology of the forest had been upset.

In less than forty years, man had changed a beautiful balanced forest with four thousand healthy deer into an impoverished area with eight thousand sickly deer.

Our lesson is clear. Predators are an essential part of ecosystems. Remove them and the whole ecosystem suffers. Every organism has a purpose, a role in the community, whether or not this is apparent to man.

Please turn to the workbook for module 8.

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TEACHING SUGGESTIONS: MAN AND ECOSYSTEMS

1. Earthworms and the Soil

a. Have a few students bring in earthworms. Let the students look at the earthworms for a few days without any direction.

b. Read the following to the class.

Bobby and Joe were planning to grow vegetables in a garden. Bobby said that earthworms were pests that would damage their crops. Joe, on the other hand, was just as sure that earthworms would help their garden. They tried settling the matter with a fist fight. Since they were well matched, after a little while each boy had numerous scrapes and bruises, but they were no closer to a solution. They finally agreed to settle the matter scientifically. They decided to plan an experiment to find out if earthworms were helpful or harmful in gardens.

c. At this point you can go one of several routes.

1. Have the students plan and carry out their own experiments.

2. Have the class do the experiment described below.

3. Describe the experiment and the observations, and have the students draw conclusions.

The experiment

Materials:

two identical wide-mouthed jars

several earthworms

two distinctly different kinds of soil (one sandy' one rich and dark)

dark paper

three bean seeds

Part A.

1. Set up the jars as shown. Put a layer of dark soil on bottom and top with a layer of sandy soil. Both soils should be moist. Place two or three earthworms in one jar.
2. Wrap dark paper around the jars. This will make the experimental conditions more closely approximate the earthworms' usual living conditions.
3. Remove the paper and observe the jars every couple of days.
4. Continue observing periodically until the soil in the jar with the earthworm is well mixed.

Part B.

Remove the earthworms and the dark paper. Place three bean seeds in each jar. Water the two jars equally.

Observe the growth of the bean plants. Measure and record the height of the plants in centimeters.

2. Write the following verse on the blackboard and ask for comments.

The Highway

by Malvina Reynolds

The highway is laid as smooth as glass
For miles and miles and the cars can pass
But the ant and the bee and the bush and the tree
Whose home it was are now exiles.
And the cars rush by for miles and miles,
To find a place where they can see
A plant, a bush, and a blade of grass,
And a ladybug, and a bee.

3. Endangered Animals

The bald eagle stands for America, but it is a threatened animal. By the time your students are grandparents there may not be any bald eagles at all. Tell them that, and ask them how they feel about it. If they seem interested, talk about some other endangered species such as some of the whales, the alligator, and many types of birds.

4. There are an estimated one million species of insects in the world. Approximately 900 species are harmful to plants, man or other animals. What per cent of all insects are pests?

This completes module #8. Please go on to module #9.

MODULE #9: THE SHAPE WE'RE IN

Anyone who reads a newspaper, watches television, or takes a good look around him knows that we have environmental problems.

Please listen to tape #9 for a brief overview of the situation.

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TAPE #9: THE SHAPE WE'RE IN

The American way of life is awfully hard on nature. We clear forests, cut roads through mountains, dam rivers, and dump chemicals in the air and water.

Listen to one person's view of America today.

(Tom Lehrer - Pollution Song)

The more people we have, the worse the problem becomes. In one sense, the average American baby is equivalent to about eighty Indian babies. In his lifetime the American will use eighty times the resources, cause eighty times the pollution, and, in general, have eighty times the impact on the environment.

In his lifetime, the average American will eat 10,000 pounds of meat, drink 28,000 pounds of milk, pollute three million gallons of water, and use 21,000 gallons of leaded gasoline. He will discard 10,000 no-return bottles, 17,500 cans, 27,000 bottle caps, 2.3 automobiles, 35 rubber tires, 26 tons of garbage, and 9.8 tons of particulate matter.

The more people we have, the more food we need. To get more food we use more fertilizers and more pesticides. These in turn cause more water pollution.

The more people we have the more houses we need. To build these houses we need to cut down large numbers of trees. We wind up turning wilderness areas into housing developments and shopping centers. As a result we are running out of places where nature is left undisturbed.

The more people we have the more waste we produce. Each person in the United States discards about five pounds of waste per day. Our cities are inundated with solid waste.

Litter, noise, air pollution, water pollution, -all of these are aggravated by increases in population. World population growth cannot continue indefinitely. The world population at present is about 3 billion. At the present time, some ccuntries are doubling their population every thirty years or less. Eventually we will run out of space to put all these people. Already we are running out of food. Millions of people go to bed hungry every night.

But population is not the only source of difficulty. Population growth in the United States is leveling off, but we can still expect pollution and resource depletion problems to get worse. We are already experiencing shortages of some foods, and of fuel. Each person in this country is using more resources than ever before.

For example, there are two million more Americans than there were a year ago, but four million more cars. The number of cars is increasing twice as quickly as the number of people. Each additional car creates more pollution.

Eac additional car causes our fuel supplies to dwindle. And this is happening at a time when fuel is in short supply. Our needs for energy in this country are tremendous, and they are increasing at a rapid rate.

The whole problem is somewhat of a vicious circle. Here is how it was described in a recent Environmental Education Bulletin. "Utility companies promote 'total electric living', 'year-round comfort with central air conditioning' etc.

Manufacturers respond with electric toothbrushes, can openers, and other 'labor-saving appliances' that border on the ludicrous. And the consumer responds by purchasing the electric wonders to satisfy his carefully nurtured 'needs'."

"Naturally all that use of electricity puts a strain on the capacity of utility companies. They talk of brownouts - and the need for more power. 'The customers are demanding it,' they point out. Then come more power generating plants, which add more pollution to the already befouled air..."

The point of the article is that it is time to call a halt to the vicious circle.

The earth has limited resources - a finite supply of energy, minerals, and other substances. The earth has the same amount of water as it did in 1900, but the use of water has increased tremendously. Water use per person in the home is up four times since 1900. The use of water by industry and for agriculture have each increased six-fold in that time.

We're using more water, but enjoying it less. Beaches on the Atlantic Coast have been closed due to sewage contamination. Oil spills on the west coast have also caused beaches to be closed. Industrial waste in Lake Erie killed off fish and made the lake unfit for swimming.

In Maryland, the clam industry had to shut down because of pollution. Chemicals in the water had made the clams unfit to eat.

Pollution disrupts the balance of nature. Here are some of the ways a water ecosystem might be harmed.

Farmers use fertilizers to help the crops grow. Rain carries some of the fertilizer into the streams and lakes.

Here, too, the nitrogen and phosporous in the fertilizer cause accelerated growth of plant life. But what was a beneficial effect on land is very detrimental to the balance of nature in a water ecosystem. When the fertilizer gets in the water it causes the algae to grow rapidly. This is fine during the day, because the algae are producing more oxygen than they are using up. At night, however, algae stop producing oxygen but continue to use oxygen for respiration. As a result the fish run out of oxygen and die. The same thing happens when phosphate-rich detergents wind up in aquatic ecosystems.

Industrial practices can also upset the balance of nature in water ecosystems. Industries along rivers use water to cool their equipment and then they dump the warm water back into the river. As you will recall from an earlier discussion, the increase in temperature causes living things to grow faster. This results in algae blooms and fish kills.

Industries can also harm water ecosystems by dumping chemicals which are byproducts of the manufacturing processes. We usually do not know in advance what effect each chemical may have. Sometimes whole populations of organisms are wiped out.

Water pollution is a serious problem, but it is by no means the only one. Air pollution is a major problem. Polluted air costs us billions of dollars a year. If you live in an urban area you probably need to paint your house more often than those in rural areas. Polluted air causes paint to peel and discolor.

Polluted air causes rubber to crack, and nylon to run.

It rusts iron, deteriorates steel, and tarnishes silver.

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Air pollution ruins crops, and kills cattle.

Most seriously, air pollution is a definite health hazard. In 1948 in Donora, Pennsylvania smog killed twenty people. More than five thousand people became ill. A London smog in 1952 killed four thousand people in four days. In Los Angeles, children are not allowed to play out of doors on certain days due to the danger of smog.

Air pollution contributes to diseases such as emphysema, bronchitis, and other respiratory diseases. If you live in a polluted urban area you are twice as likely to develop lung cancer as your rural counterpart.

These facts could be changed. We have the technology to prevent much of the air pollution that exists today. But technological capability is not enough. It will take some new laws and stricter enforcement of some old laws. Above all, it will take an informed and concerned citizenry.

The workbook contains some suggestions for teaching our future citizens about the problems we face.

ACTIVITIES: THE SHAPE WE'RE IN

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ASSIGNMENT 8

Read this article and briefly describe your reaction to it.

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The following analogy is quoted from Richard Heiss and Noel McInnis.

CAN MAN CARE FOR THE EARTH?

Imagine that we could compress the world's present population of over three billion persons into one town of one thousand persons, in exactly the same proportions. In such a town of 1,000 persons there would be only 70 Americans. These 70 Americans, a mere 7 per cent of the town's population, would receive half of the town's income. This would be the direct result of their monopolizing over half of the town's available material resources. Correspondingly, the 70 Americans would have 15 times as many possessions per person as the remainder of the townsmen.

The 7 per cent American population would produce 16 per cent of the town's food supply, eating nearly twice as much as necessary and storing for their future use, at tremendous cost, most of what they were unable to immediately consume. With most of the other 930 inhabitants of the town hungry, there would undoubtedly be hard feelings.

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The 70 Americans would have an average life expectancy of 70 years, the other 930 less than 40 years. The lowest income group among the Americans, even though it included a few people who were hungry much of the time, would be better off by far than the average of the other townsmen. The 70 Americans and about 200 other representing Western Europe, and a few classes in South America, South Africa, Australia, and Japan, would be well off by comparison with the rest.

Could such a town in which the 930 non-Americans were quite aware of both the fact and the means of the Americans' advantages, survive? Could the 70 Americans continue to extract the majority of the raw materials essential to their atandard of living from the property of the other 930 inhabitants? While doing so, could they convince the other 930 inhabitants to limit their population growth on the thesis that resources are limited? How many of the 70 Americans would have to become soldiers? How many of their material and human resources would have to be devoted to military efforts in order to keep the rest of the town at its present disadvantage?

Chances are the 70 Americans would have to organize into a military camp in order to maintain their material dominance of the remainder of the town. Chances are that most Americans would be too insecure or guilty about their situation to enjoy their dominance. Chances are this guilt and insecurity would lead some of the Americans to protest the situation and call for a change. Chances are that the protesting Americans would

find themselves subjected to variations of the same repressive forces being used to subdue the other 930 townspeople. Chances are the military camp would also be a police camp.

The most regretful thing about the situation you have been asked to imagine is that it is not imaginary. For such is the present material relationship and the incipient political relationship is very clear: The United States is systematically plundering the planet's physical resources. And if the political conclusions drawn from the above are not yet so, they are rapidly becoming so. The logical complement of a nation of plunderers is a nation of police.

1. Population Problems

In the United States, one baby is born every 9 seconds. Someone dies every 16.5 seconds. Use those statistics as the basis for some mathematics problems. For example:

a. How many children are born in one minute? in one hour? in one day?

b. How long does it take to have an additional 10 children born? 100 children? 990 children?

c. How many people will have died during the time it took for 990 children to be born?

d. In one year (365 days) what would be the net increase in the United States population?

2. Water consumption

The average American uses sixty gallons of water per day in the home.

flushing toilets	41%
washing and bathing	37%
kitchen use	6%
drinking water	5%
washing clothes	4%
general household cleaning	3%
watering the garden	3%
washing the car	1%

Use of water outside the house - for factories, farms, schools, stores, etc., - averages out to about 200 gallons of water per person per day.

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ASSIGNMENT 9

Write three mathematics problems for your students to do based on the water use figures for the home and outside the home. For example:

How many gallons of water would a family of four use in a week? A family of six?

If the population of the United States is 209 million people, how much water is needed outside the home each day?

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3. Conservation of water

Adjust a water faucet so that there is a steady drip of water. Ask the students to guess how long it will take for a particular container to be filled. Then time it.

Repeat, this time using a measuring cup. Find out how much water is wasted in one hour. Use this figure to calculate (a) the amount of water wasted in one day, and (b) the amount of water wasted in a year if each of 250 faucets is dripping.

Encourage the students to check the water faucets in their homes to make sure they are not dripping. Fixing a leaky faucet is usually a simple matter of replacing a washer.

4. Pollution

Have each student write about the ways in which his life is affected by pollution. Ask each of them to include his own definition of pollution.

5. Mathematics Problems

As a homework assignment have the students use mathematics problems to find the caption for a cartoon. If these problems are inappropriate for some or all of your students, feel free to substitute your own problems.

1. 42 6= 8-bow 7-now 6-horses

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Since 7 is the correct answer to question 1 the first word in the caption is "now".

2. 22 ÷ 1/2= 11-when 14-are 10.5-am

3. 0.5 × 5= 2.5-the 5-better 25-we

4. 1/2+1/3= 2/5-supposed 5/6-bag 1/5-than

5. 2.2+4.8= 7.0-fills 6.6-to 8-cars

6. (-1)+(-3)= (-2)-know (-4)-up (+2)-bicycles

7. 2 × (2+3)= 6-are 7-you 10-we

8. 1/4 × 8= 2-just 1/32-know 32-cleaner

9. 14.6 - 3= 42-walking 43.8-remove 42.8-the

10. (3 × 5)+(4 × 2)= 23-it 15-can't 33-gives

11. 3^4 = 6-you 9-and 27-do

12. 1/4 - 1/2= 1/8-dump 3/4-my 2/6-much

13. .75 × 20= 5-problems 12-old 15-it

14. 6.3-2.8= 3.5-out 2.5-problems 9.1-exercise

The cartoon:

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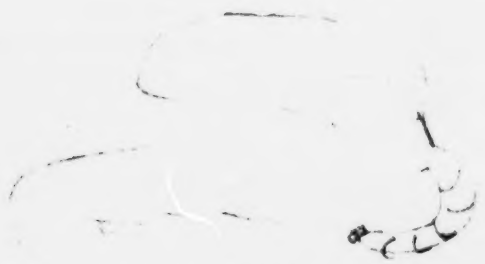

"Now when the bag fills up we just remove it and dump it out."

6. Air Pollution

Compare the amount of dust in the air in several indoor spots. To do this, coat the top side of some 3x5 cards with petroleum jelly. Examine the cards after a few days.

A different procedure should be used for testing the amount of particulate matter in the air outside. Soak a cloth in vegetable oil. Put the cloth on a frame made from a coat hanger. Suspend this from a window for several days.

7. Noise Pollution

Tell your class it has been given the task of writing a noise ordinance for your town. Divide the class into groups. Have each group write an ordinance. Their first step should be to define noise.

8. What happens to things you throw away?

Fill a box half-way with soil. Add some wastes such as a soda bottle, a can from vegetables, an aluminum beer can, a piece of newspaper, carrot peels, and a piece of leftover meat. Cover the box with wire mesh, and place it outside.

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Observe it periodically. The things that decay are biodegradable. They are returned to the ecosystem where they can be reused. Aluminum and plastic are examples of non-biodegradable substances.

9. New uses for discarded items

Point out that with a little ingenuity we can make good use of leftover materials. As examples consider orange-crate furniture, watermelon rind pickles, ripped nylon stockings used to make stuffed animals, etc.

Empty the class wastebasket. Divide the class into teams. Have a contest to see which team comes up with the best suggestions for further uses.

For homework, have the students list everything discarded in one week at home, and how some of these things might be reused.

10. The Litter Problem

Experiment on the effect of a messy environment on littering.

a. Have the classroom completely free of litter when the students come in. At lunchtime or at the end of the day clean the room again. Save every piece of litter in a labeled box.

b. On another day have the room fairly well littered, but not obviously so. Know which pieces you put down. At lunchtime or the end of the day (whichever you did last time)

collect all the litter. Discard the pieces you had put down and save the rest in a labeled box. If this box has considerably more in it than the first box do part c.

c. Show students the two piles. Don't tell them where you picked them up or when. Simply tell them each was collected in the same space, covering the same amount of time. Have them guess the reason for the difference. Then tell them what really happened.

11. Solving the Litter Problem

Discuss the litter problem with your students. Ask them how the problem might be solved. Have them suggest ways to stop littering around the school. Perhaps they can decorate wastebaskets or write a play to convince people not to litter.

12. Role Playing

Use role playing to study the litter problem. Some possible situations are:

a. One student has just thrown a gum wrapper on the ground. His friend attempts to convince him to pick it up.

b. A student sees the teacher littering and then ...

Have students play the roles of students and teachers.

13. Art from Litter Take the class on a walk around the school grounds. Each student should collect as much litter as he can and take it back to the classroom. Have students use

litter to create art objects. These might be collages, sculptures, mobiles, or anything else they think of.

SELF-TEST: THE SHAPE WE'RE IN

1. Discuss the relation between population and pollution.

2. The chief source of air pollution in the United States is

   a. industry
   b. forest fires
   c. agriculture
   d. cars

3. Give an example of a non-biodegradable waste.

(Answers appear on the next page.)

ANSWERS TO SELF-TEST

1. Population growth aggravates pollution problems. We need to have more food, more energy, more clothing, more houses, more schools, etc. All of this causes increased strain on the environment. But population is not the only cause of pollution. Pollution in the United States is increasing much faster than the population.

2. The answer is d. Cars cause almost half of all air pollution in the United States.

3. Plastics, aluminum foil, and glass are all non-biodegradable substances.

This completes module #9. Go on to module #10.

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MODULE #10: THE ONLY EARTH WE HAVE

The Environmental Protection Agency distributes an emblem which says, "I Can Save the Earth." The point is tat each of us causes environmental problems, and each of us can help cure them. As has been said about another issue, "If you're not part of the solutiсn, you're part of the problem.

Please listen to tape #10 for a discussion of what you can do to help save the earth.

TAPE #10: THE ONLY EARTH WE HAVE

One of the most important byproducts of our space program has been the photography. For the first time all of us can see the earth for what it is - a rather small sphere of land, water, and atmosphere.

The conclusion is straightforward: If we ruin this planet we are sunk. There is nowhere else to go, and no other resources to make use of.

The earth is finite, with a finite amount of space, minerals, water, and food. Unless we recognize this finiteness and act accordingly we will not survive.

One approach to dealing with the problems of resource depletion and pollution is through legal measures. The National Environmental Policy Act is a step in the right direction. One of its provisions governs major federal actions which will significantly affect the environment. The long and short-term effects of federal projects on the environment must be considered before a project is given the go ahead. This is the essence of environmental decision making. Before you act, consider the likely consequences of your actions.

Laws are not the only means of preventing further environmental deterioration. There is much that you as an individual can do to help solve these problems. Consider your automobile, as an example. Automobiles are the major source of air pollution. They put out a tremendous amount of carbon monoxide, a colorless, odor-free, poisonous gas which can cause illness and death.

There are many ways to cut down on the pollution caused by automobiles. When you need a new car, consider the lower horsepower models. They are more economical and pollute a lot less. Make sure your car is properly tuned, that anti-pollution devices are installed and working properly. Use the fuel that will most reduce emissions for your car engine. Don't buy a second car unless it is absolutely necessary. Form car pools for driving to work - it is more restful and at the same time cuts pollution considerably. Walk or ride your bicycle whenever possible. Both are good for your health. Use mass transportation when possible. This reduces pollution, and it may even be faster.

The first Invitational Commuter Race was held in San Francisco in December, 1971. A bicycle was competing with an automobile and a streetcar during rush hour. The bicyclist won easily, a full twelve minutes ahead of the streetcar. The automobile finished last.

The automobile is only one of the causes of pollution. You can do a lot to protect our environment from other sources of pollution. Be a concerned consumer. Use a low phosphate detergent, or one without any phosphates. And cut down on the amount of detergent you use. A thick layer of suds won't get your clothes any cleaner, and it adds to the pollution in our waters.

Keep pesticide use to an absolute minimum. Reach for the fly swatter rather than the spray can. If you must use a pesticide, choose one carefully and use it sparingly. No-pest strips are dangerous, especially when used in the kitchen or near children or old people. If you must use a pesticid in

the home, use a pyrethrin-based spray. Never use the hard pesticides such as DDT, dieldrin, or endin. If you have any of these poisons around the house call the health department for advice on getting rid of them. Never flush them down the toilet or pour them into lakes or streams.

Buy soft drinks in returnable containers, and make sure you return them. A returnable bottle is reused twenty times, on the average. A no-deposit bottle is used once and then makes the trip to the city dump. Or what is even worse, it winds up as litter alongside the highway.

Buy items that are simply packaged. We pay dearly for overpackaged items. They cost more to produce, and they aggravate the solid waste problem.

Buy larger sizes of foods and other products. The amount of packaging per ounce is less and so is the cost per ounce.

Don't buy colored paper towels, facial tissues or toilet paper. White paper is just as effective and pollutes less. Actually the less paper you use the better off is the environment. Use rags and sponges instead of paper towels. Anything that can be reused is better than a throw-away.

Recycle as many things as you can. Scouts and other groups periodically collect and sell newspapers, cans, and glass. Some communities are setting up permanent recycling stations. If your community has recycling stations, be sure to use them. If not, perhaps you can help to get them set up. A little extra effort can do the environment a whole lot of good.

Conserve energy. Buy only the essential electric appliances. Ask yourself, "Is an electric paper towel

dispenser really necessary?" In the summer use appliances during the cooler part of the day when possible. Otherwise the heat they give off will add to the burden on your air conditioner.

If you're building a new house be sure it is well insulated and has an abundance of trees shading it. You'll save on heating in the winter and cooling in the summer.

Don't leave lights burning unnecessarily, and try not to open the refrigerator more often than necessary.

Simple conservation measures such as these will help ease the energy crisis, and simultaneously save you money. The things that help the environment are helping you too.

Some environmental problems cannot be solved by each individual looking out for his best interest. Sometimes regulation is necessary for the good of all. Consider a hypothetical situation:

This is a large meadow as it used to look. Six shepherds used it as a common grazing area for their sheep. For a long time everything went along smoothly. There was plenty of grass for all of the sheep. Each of the shepherds was able to earn a good living by raising sheep.

One day one of the shepherds decided he would like to make a larger profit. He reasoned this way: "Each sheep that I add to my herd will bring me additional money. I will get the total benefit, but all of the shepherds will share the costs of the added sheep." So he added another sheep to his herd. And another. And another.

Meanwhile each of the other shepherds was reasoning along the same lines. And, of course, each of them reached the same

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conclusion: it made good sense to add sheep to the herds. Gradually the herds got bigger and bigger.

The more sheep there were, the more food was needed. The pasture soon became overgrazed. The grass plants were killed by hungry sheep who ate the roots of the plants. In a short time the once green pasture became a barren desert. The sheep starved to death, and the shepherds were ruined.

The decision which had made so much sense on an individual basis turned out to be a disaster for the group as a whole. This type of situation has been called a "Tragedy of the Commons" by Garrett Hardin.

There are many analogous situations. For example, we use the ocean as a "commons". As populations increase and the demand for food grows, each nation tries to harvest more and more of the ocean's food. The decision seems wise from the individual nation's point of view. But with many nations making the same decision, some species are being driven to extinction. If this continues, the ocean food supplies will be destroyed.

How do you prevent a tragedy of the commons? The solution seems obvious. Decisions of this sort cannot be left up to the individual. This is where we need collective decision making. The shepherds could have gotten together and decided how many sheep the common grazing area could support, and thus how many sheep each could have. Steps of this sort are already being taken in the case of food from the oceans. An international committee has been formed to study the matter and come up with fair and workable regulations.

Environmental decision making is a complex task. If we

close down a factory because it pollutes we are at the same time taking jobs away from hundreds of people. On the other hand, if we let the factory continue to pollute we may be endangering the well-being of many more people. Decisions of this sort are never easy, but they must be made every day.

In about ten years your students will be voting on issues that affect the quality of life in America. It is up to you and others like you to see that they are prepared to make these vital decisions.

Please turn to the workbook.

ACTIVITIES: THE ONLY EARTH WE HAVE

1. Environmental Values

One of the things that complicates environmental decision-making is the fact that different people value different things. Students should be helped to realize that there are a wide variety of value systems. Decisions should not be based on only one point of view.

This verse by Malvina Reynolds can be used to stimulate discussion of environment-related value decisions.

1 The bird watchers - there's a laugh
2 Their idea of having fun
3 Sitting on a hillside under the sky
4 Sensing the trees and feeling the sun
5 Watching the birds who nest and fly
6 Watching the castle clouds go by
7 Watching the flowers, watching the bee
8 When they could be sitting at home with a beer
9 Watching TV

Write lines 3-7 on the blackboard, leaving sufficient space for the rest of the lines. Ask for the students' opinions about the experience that is being described. Does it sound pleasant? Why?

After a while add in the other lines. Discuss how this changes things. Which seems like it would be more fun?

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3. What the Individual Can Do

The class can develop its own list of "Environmental Do's and Don'ts." Once this is accomplished, decide how best to publicize the list. The students might want to make posters, or publish the information in the school paper, or they may have some other ideas for disseminating the information.

4. Consumer Choices

Compare the price per ounce of coke in returnable bottles, no-deposit bottles and cans. Be sure to establish the idea that what is best for the environment (returnable bottles) is also the least expensive. Similarly, compare the price per ounce of the smallest and largest boxes of cornflakes or another breakfast cereal. The large box is cheaper, and it has less packaging material. As another example, compare the price per ounce of a large container of salt and the small "convenience" package.

5. Recycling

If the students want to do something about pollution problems they might try recycling. Each ton of paper that is recycled saves seventeen trees from being cut down. The air will be cleaner, too, since fewer papers will be burned. Scrap paper dealers buy back clean, bundled

newspapers for fifty cents per hundred pounds. Glass and cans can also be recycled.

6. Man's dependence on conveniences

We are dependent on nature. We have also become dependent on many modern conveniences. To dramatize this dependence, plan to have days where you and the students try to do without certain types of things.

a. For example, do without animals for one day. Try not to eat or wear anything which came from an animal. Keep a record of what you did eat and wear. Have the class look for mistakes. Encourage honesty. Sometimes it really is impossible to do without an item.

b. Do without electricity. Unplug the clock. Teach without lights. Encourage students to try this at home.

c. Do without paper and cardboard for one day.

d. Do without the telephone.

e. Do without metal of any kind.

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ASSIGNMENT 10

Write a story of a "Tragedy of the Commons" that would be meaningful to your students. Perhaps the "commons" could be something in or around the school.

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7. Tragedy of the Commons

Use your story to begin a lesson on the need to have laws in our society. Perhaps have the students think up their own examples of "tragedies of the commons." Then have the class formulate a "law" that would prevent one of those tragedies.

8. Conservation of Energy

Assign the following for homework: Take notes as your mother prepares dinner. List every energy-consuming gadget she uses. How could some of these uses of energy have been avoided?

9. Advertising

Television has an impact on environmental decision making. Programs such as the "Brady Bunch" convince us that it is a lot of fun to have a large family. Advertisements have convinced us that long, sleek, highpowered cars are the things to own. We could be convinced to want economical, easy-to-park, small cars which pollute less than the metal monsters.

Have your students look for examples of anti-environment advertising. Also look for cases where a company has jumped on the ecology bandwagon. In such cases the product is no more ecologically in tune than before, but their advertisements are.

ENVIRONMENTAL EDUCATION RESOURCES

The Science Division of the State Department of Public Instruction has prepared "A Guide to Environmental Education Resources" which is included with this package. The Science Division has other environmental education materials which can help ycu in curriculum planning.

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ASSIGNMENT 11

Write for free copies of the following:

Environmental Education: Concepts, Activities, Jibliography.

Environmental Education: Problems, Projects, and Exercises.

They can be obtained from the Division of Science Education, State Department of Public Instruction, Raleigh, North Carolina, 27602.

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Additional Recommendations for Teachers

Carson, Rachel. Silent Spring, Greenwich, Connecticut: Fawcett, 1962. $.75

Farb, Peter. Ecolcgy, Morristown, New Jersey: Silver Burdett, 19 .

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Ehrlich, Paul R. The Population Bomb second edition, New York: Ballantine Books, 1971. $.95

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Morris, Desmond. The Naked Ape, New York: Dell, 1967. $.95

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Ames, Gerald. Food and Life, Mankato, Minnesota: Creative Education Society, 1966. $5.95

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Aruego, Jose. Symbiosis, A Book of Unusual Friendships, New York: Charles Scribner's Sons, 1970. $3.95

Benarde, Melvin. Race Against Famine, Eau Claire, Wisconsin: E. M. Hale, 1970. $3.75

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Bulla, Clyde. A Tree is a Plant, New York: Crowell, 1962.

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Cormack, Maribelle. First Book of Trees, New York: Franklin Watts, 1951.

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Dudley, Ruth H. Partners in Nature, New York: Funk and Wagnalls, 1965.

Dwiggins, Don. Spaceship Earth: A Space Look at our Troubled Planet, San Carlos, California: Golden Gate Junior Books, 1970. $4.27

Fisher, Todd. Our Overcrowded World, New York: Parent's Magazine Press, 1969.

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Lubell, Winifred and Cecil Lubell. Green is for Growing, Chicago: Rand McNally 1964.

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Mattison, Charles. Man and his Resources, Mankato, Minnesota: Creative Education Society, 1967. $5.95

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Newman, L. H. Man and Insects: Insect Allies and Enemies, Garden City, New York: Natural History Press, 1966. $6.96

Pringle, Laurence. Ecology: Science of Survival, New York: MacMillan Company, 1971. $5.59

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Warner, Matt. Your World: Your Survival, New York: Abelard Schuman, 1970. $4.25

One of the best sources for environmental education material is the National Wildlife Federation. Each year they put out an "EQ Index" which assesses the state of the environment and gains and losses since the previous year.

The National Wildlife Federation also publishes Ranger Rick's Nature Magazine, an excellent journal for upper elementary school students. The cost of a one-year subscription is six dollars.

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ASSIGNMENT 12

Write for a copy of the latest "EQ Index". Also ask for the following Ranger Rick reprints: "Recycling", "The Mess We're In", "Pesticides are Perilous", "Air Pollution", and "Water - What would You Do Without It?"

Single copies are available free from:

Educational Servicing
National Wildlife Fedetation
1412 16th St. N. W.
Washington, D. C. 20036

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ASSIGNMENT 13

a. How effective is your school library as an environmental education resource center for you and your students?

Write an evaluation (approximately one page) of your school library as it relates to environmental education.

b. Prepare a list of environment-related books and periodicals you would like the library to order as funds are available. Include the name of the publisher and the price of the book. Send a request for these materials to the librarian. Keep a copy of that request for your files, and hand in a copy with your other assignments at the completion of this package.

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Films

In general, these films are appropriate for grades 4-8. They usually need to be booked well in advance. All of the films listed here will be mailed to you free of charge. You will have to pay postage, which usually is between ten and fifteen cents. Be sure to tell the post office you are mailing educational material so you can get this low rate.

1. All the Difference

This twenty minute color film compares America today to the less polluted, more beautiful America of the past. It is a plea for environmental preservation. Write to:

Eastman Kodak Company
Audio-visual Distribution
343 State Street
Rochester, New York 14650

2. The Endless Chain (1971)

This twenty-eight minute color film describes food webs and cycles of life in the desert. Write to:

United States Atomic Energy Commission
Savannah River Operations Office
Office of Public Information
Post Office Box A
Aiken, South Carolina 29802

3. The Farm

This beautiful film shows how a farm in Maryland is run ecologically. It is a twenty-eight minute color film. Write to:

Modern Talking Picture Service, Inc.
503 North College Street
Charlotte, North Carolina 28202

4. The Greatest Good (1968)

This twenty-eight minute color film illustrates the need for cooperation between ndustry and conservation groups. It is presented from the industrial point of view. Write to:

Colorado Mining Association
402 Majestic Building
209 Sixteenth Street
Denver, Colorado 80202

5. Money to Burn

This is a twenty minute film, in color, bout the litter problem. Write to:

Texas Highway Department
Film/slide Library
Travel and Information Division
Post Office Box 5064
Austin, Texas 78703

6. So Little Time

Beautiful photography in a twenty-eight minute color film on the need for conservation of wildlife. Write to:

Bureau of Sport Fisheries and Wildlife
Fish and Wildlife Service
809 Peachtree- Seventh Building
Atlanta, Georgia 30323

7. Wildlife Babies

This twenty-five minute color film shows the young of several wildlife species in their natural environments. Write to:

Division of Education
Wildlife Resources Commission
Post Office Box 2919
Raleigh, North Carolina 27602

8. A Way of Life

This twenty-seven minute color film explains the importance of predators in nature. Write to:

Division of Education
Wildlife Resources Commission
Post Office Box 2919
Raleigh, North Carolina 27602

9. Conservation and Balance in Nature

Basic ecological principles are described in this eightteen minute color film. Write to:

Division of Education
Wildlife Resources Commission
Post Office Box 2919
Raleigh, North Carolina 27602

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ASSIGNMENT 14

One good way to help students learn about their environment is to bring in people from the community who can talk to them about environmental issues. Prepare a list of people you might ask to talk to your class. Include the topics they would be asked to speak about.

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QUESTIONNAIRE

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ASSIGNMENT 15

Please help us to improve future in-service programs by answering the follcwing questions.

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1. Was the level of difficulty of the material appropriate for you?

2. What are the best points of this package?

3. What are the worst points?

4. What else do you think should be included in this package?

5. Do you think this experience will improve your teaching? Explain.

6. If you need renewal credit in the future, what type of experience would you prefer?

Rank order your choices. 1=first choice

---- a college course

---- a workshop

---- a self-instructional package

Additional comments:

Thank you for your cooperation.

ASSIGNMENT LIST

Bring the five tapes, the ten sets of pictures, and all of the completed assignments to the meeting on

ASSIGNMENTS

1 Reaction paper

2 Field trip plan

3 Names of poems

4 Relationships among living things

5 History cycle story

6 Adaptations for survival

7 Uses of plants

8 Mathematics problems

9 "Can Man Care For the Earth?"

10 "Tragedy of the Commons"

11 Letter to State Department of Public Instruction

12 Letter to National Wildlife Federation

13 School Library

14 List of Guest Speakers

15 Questionnaire

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TEST ON ECOSYSTEMS

Choose the best answer for each question. Using a #2 pencil, blacken the corresponding space on the answer sheet.

1. In the desert, where water is scarce, plants rarely grow close together. The relaticnship between two plants in the desert is

    1. predation
    2. mutualism
    3. commensalism
    4. competition

2. Lichen is actually made up of two plants growing in close association. The fungus anchors the plant and absorbs water. The algae produces food. The relationship between the algae and the fungus is

    1. mutualism
    2. parasitism
    3. competition
    4. commensalism

3. Barnacles often attach themselves to whales. This provides the barnacle with locomotion to a new feeding place, but does not affect the whale. The relationship between the barnacle and the whale is

    1. parasitism
    2. commensalism
    3. predation
    4. competition

4. The chief source of air pollution in the United States is

    1. power plants
    2. cars
    3. industry
    4. burning refuse

5. The process by which one community is replaced by another is called

    1. ecology
    2. predation
    3. succession
    4. photosynthesis

6. Which of the following is a producer?

1. mushroom
2. elm tree
3. snake
4. fly

7. The interaction of biotic and abiotic environmental factors is best illustrated by

1. a hen incubating her eggs.
2. two dogs fighting over a bone.
3. a young pine tree dying after an ice storm.
4. a river's level rising due to excessive rainfall.

8. Which of the following could be completely removed without ultimately causing an end to life on earth?

1. man
2. green plants
3. decomposers
4. producers

9. Which of the following is a biotic factor of the environment?

1. moisture
2. light
3. predators
4. temperature

10. The producers in a community take sun energy and convert it to chemical energy (or food.) This process is called

1. diffusion
2. respiration
3. photosynthesis
4. succession

11. What would happen if all decomposers were eliminated?

1. nothing at all
2. Plants and animals would live longer and reproduce more often.
3. There would be an abundance of food so animals would no longer have to compete for it.
4. The earth would be littered with garbage, and the bodies of dead organisms.

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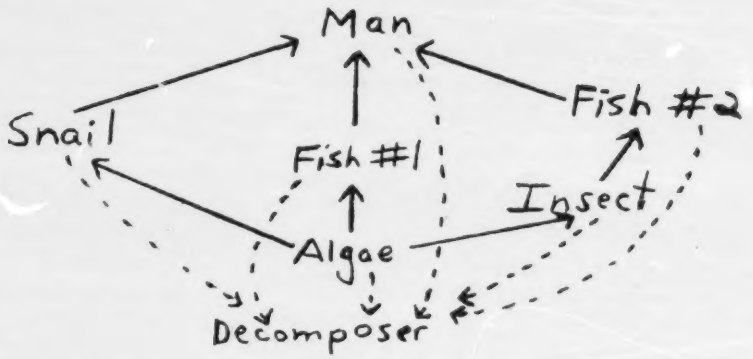
Answer questions 12 - 14 based on the diagram below.



12. In this food web man would be a third order consumer if he ate

1. fish #1
2. fish #2
3. the snail
4. the algae

13. The only producer in this food web is the

1. snail
2. decomposer
3. fish #1
4. algae

14. Assume a mosquito bites the man. In which sequence would the mosquito be a fourth order consumer?

1. algae, man
2. algae, insect, fish #2, man
3. algae, snail, man
4. algae, snail, decomposer, man

15. The correct order of bare-rock succession is

1. moss, grass, lichen, large trees, small trees.
2. small trees, large trees, moss, grass, lichen.
3. grass, moss, small trees, lichen, large trees.
4. lichen, moss, grass, small trees, large trees.

16. In an aquarium, oxygen is produced by

1. aquatic plants
2. fish
3. snails
4. bacteria

17. An example of adaptation by camouflage is

1. a bird's feathers turn from brown to white in winter.
2. a tree loses its leaves in autumn.
3. a desert snake is active only at night.
4. a beaver grows a thick fur coat for winter.

18. The problem of air pollution

1. can be solved now if people demand it
2. can never be solved
3. can only be solved through new scientific discoveries
4. may be solved some day but it will take at least 20 years.

19. The world food supply per person is

1. the same as it was fifty years ago
2. going up and down in cycles
3. increasing
4. decreasing

20. The process by which food is broken down into carbon dioxide, water and energy is called

1. diffusion
2. respiration
3. photosynthesis
4. succession

21. Which of the following <u>cannot</u> be traced back to plants?

1. milk
2. turkey
3. salt
4. sugar

22. Shortages of fresh water supplies in the last fifty years have been caused by all of the following <u>except</u>

1. increased population
2. increased per capita use of water in the home
3. increased use of water by industry
4. decreased rainfall on a worldwide scale

23. Killing all the predators in an area will result in

1. increased plant growth
2. a healthier, more stable ecosystem
3. upsetting the balance of nature
4. decreased pollution

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24. A water molecule is part of the abiotic environment when it is in a

1. lake
2. cactus
3. mouse
4. whale

25. Which of the following is <u>not</u> part of the water cycle?

1. precipitation
2. condensation
3. mineralization
4. evaporation

26. A dandelion is an example of a plant which is adapted for

1. conservation of water
2. wind dispersal of seeds
3. pollination by bees
4. camouflage

27. Recycling will have the greatest effect on

1. noise pollution
2. solid waste pollution
3. air pollution
4. water pollution

28. Of the following, the one which is biodegradeable is

1. newspaper
2. glass
3. plastic
4. aluminum foil

29. The effect of fertilizers on a lake is

1. beneficial since it increases the number of game fish
2. neutral since fertilizers act only on land
3. harmful since it counteracts the work of pesticides
4. harmful since it decreases the amount of oxygen available

30. Without green plants, man would soon run out of

1. oxygen
2. water
3. carbon monoxide
4. carbon dioxide